SCIENTIFIC AMERICAN SUPPLEMENT. No. 1318

Scientific American, established 1845.
Scientific American Supplement. Vol. LI. No. 1318.

NEW YORK, APRIL 6, 1901.

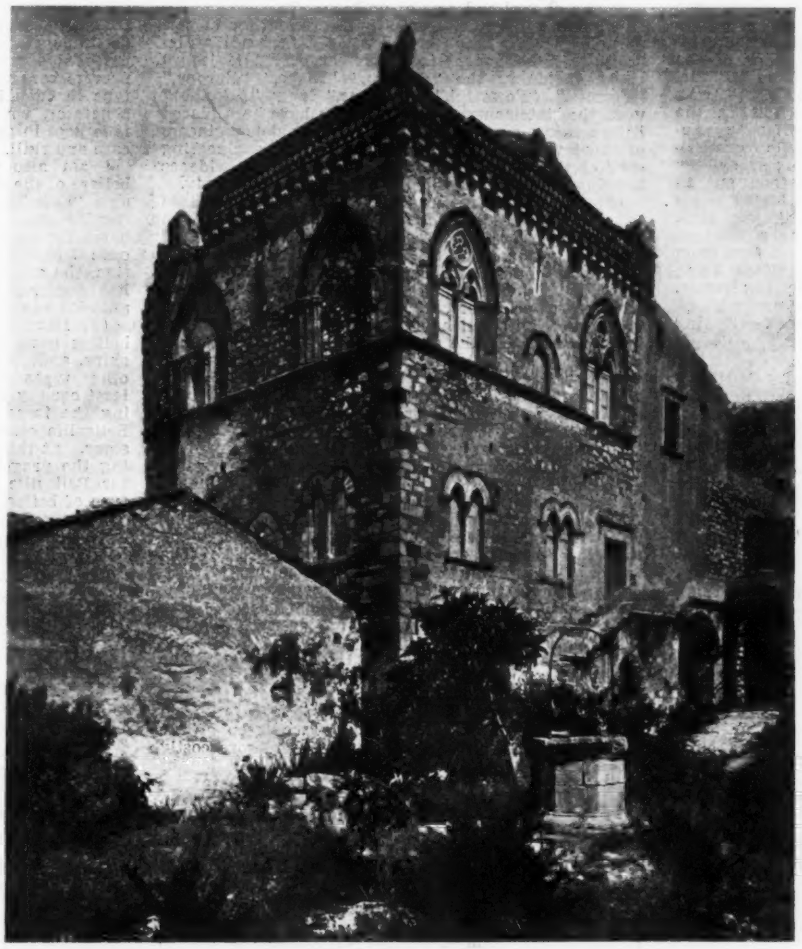
Scientific American Supplement, $5 a year.
Scientific American and Supplement, $7 a year.

TAORMINA.

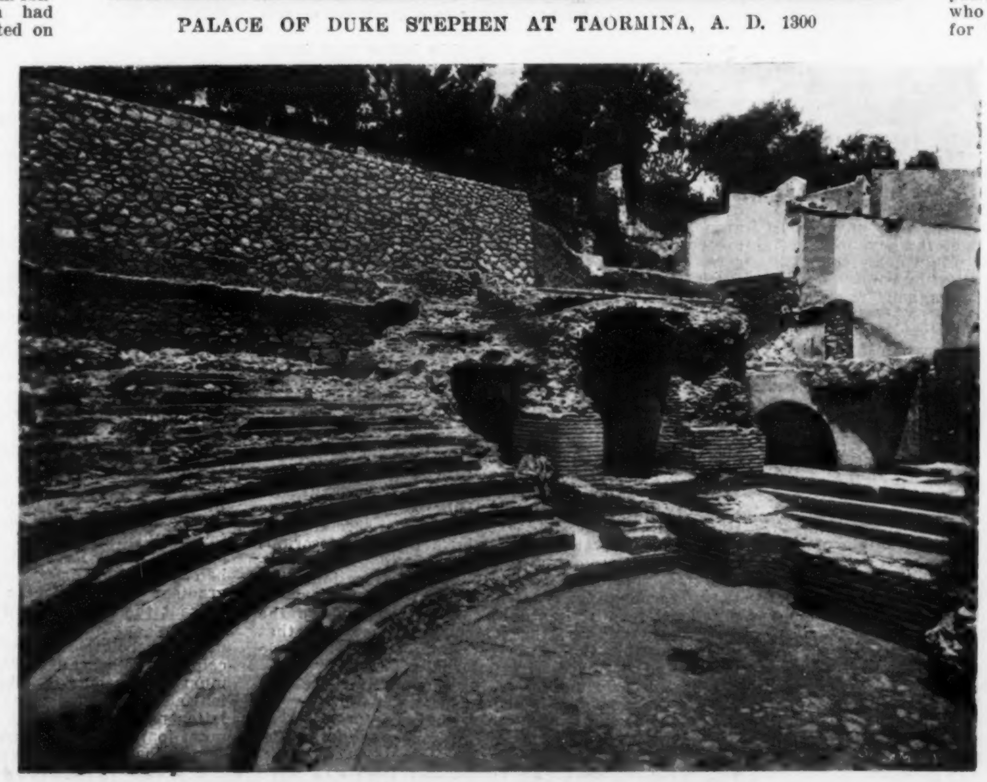
TAORMINA, in Sicily, consists of a long street with several diverging lanes, is most beautifully situated, commanded by the ruins of a castle on a rocky height 1,300 feet above the sea level. Above the latter rise the hills of Mola and farther distant is the Monte Venere, 2,834 feet.

The castle was formerly the acropolis of Tauromenium, which, after the destruction of Naxos by Dionysius in B. C. 403, was founded by the Siculi (396), to whom Dionysius granted the necessary land. They, however, soon renounced their allegiance to him and joined the Carthaginians and in 394 Dionysius besieged their town in vain. In 392, however, he succeeded in capturing it, and garrisoned it with mercenaries. In 358, Andromachus, father of the historian Timæus, who was born here, transferred the remainder of the population of Naxos to Tauromenium (comp. p. 339). Timoleon who landed on the rocks below the town was warmly supported by the inhabitants, but after his death dissensions arose. The town then joined the Carthaginians against Agathocles, for which it was afterward chastised by the tyrant. After his death the town came into the power of Tyndarion, who invited Pyrrhus to Sicily and induced him to land near Tauromenium (278). When the Romans concluded the peace with Hiero II., of Syracuse, the town came into their possession and enjoyed a long period of tranquillity. A number of the slaves established themselves here during the First Servile War, and offered a long and obstinate resistance. As the town, being an ally of Rome, had declared in favor of Sextus Pompeius and thus occasioned great embarrassment to Octavian, it afterward experienced the effect of his wrath and was peopled by a new colony. In the time of Strabo it was a place of considerable importance. Its strong position long enabled the inhabitants to ward off the attacks of the Saracens, who in 869 besieged it unsuccessfuly. But on August 1, 902, it was taken by the blood-thirsty Ibrahim-Ibn-Ahmed, after the garrison had sallied forth and been defeated on the coast. Mola, too, was captured by the Moors, the whole population massacred, and the town burned. The adherents of the Bishop Procopius, whose heart the savage Ibrahim proposed to devour, were strangled and burned on his corpse. The town, however, recovered from this cruel blow, and Hassan el Muez, the first Emir, was obliged to besiege and capture it anew in 962. He then introduced a colony of Mussulmans and named the town Muezziya. In 1078 it was taken by the Normans, under whose supremacy it again prospered. Here in 1410 was held the Parliament, which vainly endeavored to find a national sovereign to rule over Sicily. Battles were subsequently fought here on two different occasions. In 1676 the French took possession of Taormina and Mola, but on December 17, 1677, a party of forty brave soldiers caused themselves to be hoisted to the summit of the rocks of Mola by ropes (at the point where the path from Taormina skirts the base of the cliff), and succeeded in surprising and overpowering the garrison. Again, on April 2, 1849, the Neapolitans under Filangieri, "Duke of Taormina," gained possession of the town, which was defended for a few days only by a small body of troops under Sabta Rosalia.

Our engravings show the small Greek theater and the Gothic Palazzo Duca S. Stefano.



PALACE OF DUKE STEPHEN AT TAORMINA, A. D. 1300



SMALL GRECO-ROMAN THEATER AT TAORMINA.

STOLEN SECRETS.

THERE are four ways by which a man may acquire knowledge. The first is to find it for himself; the second is to be taught it; thirdly, he may buy it, if it be of such a nature that he can turn it to account in trade, and this is the method which mostly obtains in the production of new substances. Lastly, he may steal the knowledge which enables him to make a fortune. It is a process which is by no means rare; it is nowadays much easier to steal a secret than it formerly was. A hundred years ago, what a man found out in mechanics or art he kept to himself, for patents were then immensely expensive, and no one then, as now, could be sure that a particular thing could not be done another way just as well, given the initial process. Consequently, doors were kept locked, and visitors were rigorously excluded. The workmen had to subscribe to most rigid oaths, and were searched on leaving the building, and as an additional security operations were introduced into the processes which had no other object than to hoodwink the workmen, while in many cases, as is done at the present time, no one workman ever saw the object of the manufacture through all its stages. Each had one part to do, and was ignorant of what his fellow-workmen in another part of the building might be about, and thus every innovation was hedged round with a quickset of mystery. Handicrafts were handed down from father to son, and such secrets as the father had discovered or inherited were inherited by his successor, so that it often happened that one man had the monopoly of some special produce or manufacture. For instance, there used to be, close to Temple Bar, a dingy little chemist's shop. But, dingy as it was, the proprietor was a well-to-do man, for he had discovered the secret of making citric acid—that is, he had found out how to make it without the fruit, and had a monopoly of the output. But he was in a more fortunate position than most monopolists who own a manufacturing secret, for his was a process which required no assistance, and consequently he employed no workmen. Experts came to order, sample, assort, and bottle his citric acid, but all that took place in the outside shop. Nobody but he ever entered his laboratory, and his secret was locked therein and in his mind. But such a secret was too valuable to be kept without an effort on the part of rivals to fathom it. And they succeeded. One day he securely locked the door of his laboratory and went home to his dinner. But on the watch for that event was a chimney sweep, or rather a boy disguised as such, who was possessed of some chemical knowledge. He followed the poor chemist as far as Charing Cross, and saw him enter his house. Sure that he would not return for some time, the pseudo-sweep hurried back to Temple Bar, ascended the next house, and dropped down the flue of the laboratory. There, of course, he saw all that he wanted to see, and returned to his employers, carrying with him the secret of making citric acid. A few weeks afterward the price of that commodity fell to a fifth of what it was when

the monopolist alone sold it. The poor fellow was heartbroken, and died a few months after, without, however, discovering that his secret had really been filched from him.

The secret of making china was stolen by a Frenchman. The Chinese told wonderful stories to keep the process from the knowledge of foreign devils; they said that the clay from which the porcelain was made had to lie in heaps exposed to the weather for two hundred years before it could be used. Others said that it was not clay at all, but certain sea shells ground up, and that only one variety of shell would do. But in spite of all these yarns, the foreign devil was too much for them. He spent many years learning the language, and eventually was admitted to a manufactory by practising on the feelings of a local mandarin. But, even in later years, secrets in china manufacture have been stolen. For a long time Wedgwood kept to himself the secret of making the cameo ware, which even now is not very common, although it is exceedingly effective. But Turner, one of his employés, and afterward a dangerous rival, stole that secret with others and set up on his own account. Before that time the Brothers Elers came from Holland with a private process and settled in Staffordshire, where their secret was stolen by a rival potter by a peculiarly dirty trick. He feigned to be overcome by a storm, and begged shelter from the hospitable Dutchmen, and, gaining admittance in this way to their kilns, discovered their process and went on his way rejoicing. The secret of making metallic luster was stolen from the Moors by the Spaniards, and an escaped workman from the factory at Meissen took with him the secret of the Dresden china and carried it to Vienna. Böttger, the discoverer of the process, was kept in prison by Augustus II., the Elector of Saxony, and made to experiment on porcelain. By an accident he discovered the true clay—kaolin from Aue—and was then put in charge of the works at Meissen—about fifteen miles from Dresden. This factory was more like a prison. No workman ever went out. There was a military guard round the place, and the kaolin was sent from Aue in sealed bags, the greatest precautions being taken to prevent its destination from becoming known. But, inspite of these safeguards, at least one man escaped with his knowledge of the process.—Evening Standard, London.

REPORT OF THE BRITISH ADMIRALTY COMMITTEE AGAINST THE BELLEVILLE WATER-TUBE BOILER.

In September, 1900, the Admiralty appointed a committee to consider the question of modern types of boilers for use in warships. The particular questions to which the Admiralty required an answer were, first as to whether water-tube boilers were preferable to cylindrical boilers, for warships. Second, whether if they were preferable, the committee considered the Belleville type to be the best; and, lastly, the committee were requested to offer any suggestions that were prompted by the data which they had secured. The committee was composed of Vice-Admiral Sir Compton Domvile, chairman; Mr. J. A. Smith, inspector of machinery, R.N.; Mr. John List, R.N.R., superintending engineer, Castle Line; Mr. James Bain, R.N.R., superintending engineer, Cunard Line; Mr. J. T. Milton, chief engineer of Lloyd's Register of Shipping; Prof. A. B. W. Kennedy, and Mr. J. Inglis, of the firm of A. & J. Inglis, engineers and shipbuilders.

The interim report which follows was signed by all the committee, with the exception of one member, Inspector of Machinery Joseph A. Smith, R.N., who, while agreeing to most points with the majority of the report, was inclined to favor the Belleville boiler in some particulars. The report is as follows:

(1) The committee are of opinion that the advantages of water-tube boilers for naval purposes are so great, chiefly from the military point of view, that, provided a satisfactory type of water-tube boiler be adopted, it would be more suitable for use in his Majesty's navy than the cylindrical type of boiler.

(2) The committee do not consider that the Belleville boiler has any such advantage over other types of water-tube boilers as to lead them to recommend it as the best adapted to the requirements of his Majesty's navy.

(3) The committee recommend: (a) As regards ships which are to be ordered in the future: That Belleville boilers be not fitted in any case. (b) As regards ships recently ordered, for which the work done on the boilers is not too far advanced: That Belleville boilers be not fitted. (c) As regards ships under construction, for which the work is so far advanced that any alteration of type of boiler would delay the completion of the ships: That Belleville boilers be retained. (d) As regards completed ships: That Belleville boilers be retained as fitted.

(4) In addition to the Belleville type of boiler, the committee have had under consideration four types of large straight tube boilers which have been tried in war vessels, and are now being adopted on an extended scale in foreign navies. These are: (a) The Babcock & Wilcox boiler; (b) the Niclausse boiler; (c) the Dürr boiler; (d) the Yarrow large tube boiler. (a) and (b) have also been tried in our own navy with satisfactory results, and are now being adopted on a limited scale. If a type of water-tube boiler has to be decided on at once for use in the navy, the committee suggest that some or all of these types be taken.

(5) The committee recommend that the completion of the two sloops and the second-class cruiser fitting with Babcock & Wilcox boilers, and the sloop and first-class cruiser fitting with Niclausse boilers, be expedited, in order that the value of these types of boilers for naval purposes may be ascertained at the earliest possible date. This is especially important, as the Babcock & Wilcox boiler adopted in the ships under construction differs materially from the Babcock & Wilcox boiler as fitted in the "Sheldrake."

(6) The committee recommend that boilers of the Dürr and of a modified Yarrow type be made and tested at the earliest possible date, under their supervision, with a view of aiding the selection of one or more types of water-tube boilers for use in his Majesty's ships. For this purpose the committee suggest that two cruisers, not smaller than the "Medea" class, with vertical triple-expansion engines, be placed at their disposal, and that they be empowered to order at once Dürr and Yarrow boilers to be fitted to them, and to order also the removal of their present boilers and the necessary modifications to their machinery, so that the performances of the type of boilers named may be definitely ascertained under ordinary working conditions from extended sea-going trials. The committee suggest vessels not smaller than the "Medea" class, because the evidence before them shows that it has been difficult to draw from torpedo gunboat trials conclusions fully applicable to larger vessels.

(7) With reference to paragraph (1) evidence has been given before the committee to the effect that three most important requirements from the military point of view are: (a) Rapidity of raising steam and of increasing the number of boilers at work. (b) Reduction to a minimum of danger to the ship from damage to boilers from shot or shell. (c) Possibility of removing damaged boilers and replacing them by new boilers in a very short time and without opening up the decks or removing the fixtures of the hull. These requirements are met by the water-tube boiler in a greater degree than by the cylindrical boiler, and are considered by the committee of such importance as to outweigh the advantages of the latter type in economy of fuel and cost of up-keep.

(8) The opinion expressed by the committee in paragraph (2) has been formed after a personal examination of the boilers in a number of his Majesty's ships, including the "Diadem," "Niobe," "Europa," "Hermes," "Powerful," "Furious," and "Ariadne;" upon the statements of defects which have been placed before them; and the evidence of the chief engineers of those vessels and other officers on the engineering staff of the Admiralty and dockyards. This evidence is being printed, and will be forwarded when ready.

(9) The committee consider the following points in relation to the construction and working of the Belleville boiler to constitute practical objections of a serious nature: (a) The circulation of water is defective and uncertain, because of the resistance offered by the great length of tube between the feed and steam collectors, the friction of the junction boxes, and the small holes in the nipples between the feed collector and the generator tubes, which also are liable to be obstructed, and may thus become a source of danger. (b) The necessity of an automatic feeding apparatus of a delicate and complicated kind. (c) The great excess of the pressure required in the feed pipes and pumps over the boiler pressure. (d) The considerable necessary excess of boiler pressure over the working pressure at the engines. (e) The water gages not indicating with certainty the amount of water in the boiler. This has led to serious accidents. (f) The quantity of water which the boiler contains at different rates of combustion varying, although the same level may be shown on the water gages. (g) The necessity of providing separators with automatic blow-out valves on the main steam pipes to provide for water thrown out of the boilers when speed is suddenly increased. (h) The constant trouble and loss of water resulting from the nickel sleeve joints connecting the elements to the feed collectors. (i) The liability of the upper generator tubes to fail by pitting or corrosion, and, in economizer boilers, the still greater liability of the economizer tubes to fail from the same cause. Further: (k) The up-keep of the Belleville boiler has so far proved to be more costly than that of cylindrical boilers; in the opinion of the committee this excess is likely to increase materially with the age of the boilers. (l) The additional evaporating plant required with Belleville boilers, and their greater coal consumption on ordinary service as compared with cylindrical boilers, has hitherto nullified to a great extent the saving of weight effected by their adoption, and, in considering the radius of action, it is doubtful whether any real advantage has been gained. The committee are not prepared without further experience to say to what extent this may not apply to other types of water-tube boilers.

(10) At the time the Belleville boiler was introduced into the navy in the "Powerful" and "Terrible," it was the only large tube type of water-tube boiler which had been tried at sea on a considerable scale under ordinary working conditions. The committee therefore consider that there was justification for then regarding it as the most suitable type of water-tube boiler for the navy.

(11) To obtain satisfactory results in the working of the Belleville boiler, in face of the defects in paragraph (9), more than ordinary experience and skill are required on the part of the engine-room staff. It appears, however, from the evidence placed before the committee, that the engineer officers in charge of Belleville boilers have not been made acquainted with the best method of working the boilers, and that which experience has shown to be most effectual in preventing the pitting and corrosion of tubes.

(12) In view of the rapid deterioration of economizer tubes in several vessels, the committee have specially considered whether the extra power per ton of boiler at high rates of combustion, obtained by the use of economizers, has not been too dearly purchased. The evidence before them indicates that at the lower and more usual rates of combustion the "Powerful" type of boiler has given results as satisfactory as the economizer type. It is at the same time less complex, and free from the special risks of tube deterioration which have proved so serious in many cases, notably in the "Europa." They therefore recommend, for ships under construction, that the non-economizer type should be reverted to where practicable, with the tubes raised higher above the fire-bars to increase the combustion space, and that where possible the steam collectors should be made larger, and more accessible internally.

(13) The evidence before the committee shows that a large proportion of the coal expended in the navy is used for distilling and other auxiliary purposes in harbor as well as at sea. For such purposes, the cylindrical boiler is, in the opinion of the committee, more suitable and economical than any type of water-tube boiler. They recognize that there are objections to fitting cylindrical and water-tube boilers in combination, but they believe that those drawbacks would be more than compensated for by resulting advantages, observing that the cylindrical boilers could be used for supplying distilled water in case of failure or insufficiency of the evaporating plant. On these grounds it is considered desirable that all new vessels of large power should be provided with cylindrical boilers to do the auxiliary work.

(14) The committee have to state, for the information of their lordships, that a series of comparative trials for determining economy in coal and water consumption were arranged in October, 1900, for his Majesty's ships "Minerva" and "Hyacinth." The trials of the former ship commenced on January 7, as soon as she was ready, but were temporarily interrupted by recent events. The committee are, however, now informed that the "Minerva" will not be again available until after March 2, and that the "Hyacinth" will not be ready to commence her trials until the first week in April. It is proposed to include in these trials a full-speed run for both ships from Portsmouth to Gibraltar and back.

The minority report of Mr. J. A. Smith is as follows:

I concur with the above report, except as regards paragraph 3, and on the point dealt with in that paragraph my report is as follows:

(1) Although the Belleville boiler has certain undesirable features, I am satisfied, from considerable personal experience, and from the evidence of engineer officers who have had charge of boilers of this type in commissioned ships, that it is a good steam generator, which will give satisfactory results when it is kept in good order and worked with the required care and skill.

I am also satisfied, from my inspection of the boilers of the Messageries Maritimes Company's steamship "Laos," after the vessel had been employed on regular mail service between Marseilles and Yokohama for more than three years without having been once laid up for repairs, that, with proper precaution, the excessive corrosive decay of the tubes which has occurred in some instances can be effectually guarded against.

(2) Having in view the extent to which Belleville boilers have already been adopted for his Majesty's ships, and the fact that there are now three or four other types of water-tube boilers which promise at least equally good results, I am of opinion that, pending the issue of the final report of the committee, Belleville boilers should not be included in future designs. At the same time, I see no necessity for delaying the progress of ships which have been designed for Belleville boilers in order to substitute another type of boiler.

PROCESS FOR THE TRANSFORMATION OF TRICALCIC PHOSPHATES INTO BICALCIC PHOSPHATES, WITH CONTINUOUS CYCLE OF MANUFACTURE.

By M. MARTINET.

A MIXTURE is prepared in the proportion of one molecule of phosphate, PhO_4Ca_3, with three molecules of anhydrous sodium sulphate and about 25 per cent of coal.

By calcination of this mixture a double decomposition takes place, and the calcic sulphate is reduced, yielding an insoluble mixture of calcium sulphide and sodium phosphate.

On lixiviating this product, the sodium phosphate is separated.

In the second place, the sulphur contained in the residuum is recovered in the state of lime sulphydrate. This may be realized by different processes, but two are preferably employed.

In the first the insoluble residuum of the lixiviation of the sodium phosphate is drained; then, while yet moist, is subjected in thin layers to contact with air. It is thus gradually oxidized and transformed into calcium sulphide, which is converted by a jet of steam into lime sulphydrate.

In the second process this salt is obtained by utilizing the sulphur of the residues, in the state of sulphureted hydrogen, by causing this gas, produced at the time of a previous operation, to pass over the residues diluted with water.

The third phase of the process is the following: The solutions of lime sulphydrate, drawn off clear, are mixed with solutions of sodium phosphate, and by double decomposition bicalcic phosphate is precipitated (quite pure and particularly free from tricalcic phosphate), and the supernatant waters contain all the sodium employed, in the state of sodium sulphydrate, which, after calcination, can be used for a new operation.—Translated from La Revue des Produits Chimiques.

DARK CATHODE SPACE.—By means of Graham's barometer tube and exploring wires, C. A. Skinner has determined the potential gradient in Faraday's dark space. This dark space shows an abnormally low value of the potential gradient as compared with the luminous column. The results obtained by the author in his endeavor to clear up this anomaly are in many respects identical with those obtained by Stark, and attributed by the latter to "ionic shooting." With increasing current, the Faraday dark space increases in extent, driving the luminous column before it. This is accompanied by a decrease in the gradient throughout the dark space. For the same current the amount of dark space decreases with increasing gas pressure. When the gradient falls 25 per cent below its constant value in the luminous column, the space becomes dark. If we suppose maximum ionization in the luminous and minimum ionization in the dark spaces, the velocity in the latter must be sufficient to compensate for the minimum ionization there, so that the conductivity along the discharge may be greater in the dark spaces, as the gradient requires.—C. A. Skinner, Phil. Mag., December, 1900.

THE EFFECT OF PHYSICAL AGENTS ON BACTERIAL LIFE.*

THE fact that life did not exist upon the earth at a remote period of time, the possibility of its present existence as well as the prospect of its ultimate extinction, can be traced to the operation of certain physical conditions. These physical conditions upon which the maintenance of life, as a whole, depends are in their main issues beyond the control of man. We can but study, predict, and, it may be, utilize their effects for our benefit. Life, in its individual manifestations, is therefore conditioned by the physical environment in which it is placed. Life rests on a physical basis, and the main springs of its energies are derived from a larger world outside itself. If these conditions, physical or chemical, are favorable, the functions of life proceed; if unfavorable, they cease—and death ultimately ensues. These factors have been studied and their effects utilized to conserve health or to prevent disease. It is our purpose this evening to study some of the purely physical factors, not in their direct bearing on man, but in relation to much lower forms in the scale of life—forms which constitute in number a family far exceeding that of the human species, and of which we may produce at will, in a test-tube, within a few hours, a population equal to that of London. These lowly forms of life—the bacteria—belong to the vegetable kingdom, and each individual is represented by a simple cell.

These forms of life are ubiquitous in the soil, air and water, and are likewise to be met with in intimate association with plants and animals, whose tissues they may likewise invade with injurious or deadly effects. Their study is commonly termed bacteriology—a term frequently regarded as synonymous with a branch of purely medical investigation. It would be a mistake, however, to suppose that bacteriology is solely concerned with the study of the germs of disease. The dangerous microbes are in a hopeless minority in comparison with the number of those which are continually performing varied and most useful functions in the economy of nature. Their wide importance is due to the fact that they insure the resolution and redistribution of dead and effete organic matter, which, if allowed to accumulate, would speedily render life impossible on the surface of the earth. If medicine ceased to regard the bacteria, their study would still remain of primary importance in relation to many industrial processes in which they play a vital part. It will be seen, therefore, that their biology presents many points of interest to scientific workers generally. Their study as factors that ultimately concern us really began with Pasteur's researches upon fermentation. The subject of this evening's discourse—the effect of physical agents on bacterial life—is important, not merely as a purely biological question, though this phase is of considerable interest, but also on account of the facts I have already indicated, viz., that micro-organisms fulfill such an important function in the processes of nature, in industrial operations, and in connection with the health of man and animals. It depends largely on the physical conditions to be met with in nature whether the micro-organisms exercise their functions, and likewise whether they die or remain inactive. Further, the conditions favoring one organism may be fatal to another, or an adaptability may be brought about to unusual conditions for their life. To the technologist, the effect of physical agents in this respect is of importance, as a knowledge of their mode of action will guide him to the means to be employed for utilizing the micro-organisms to the best advantage in processes of fermentation. The subject is of peculiar interest to those who are engaged in combating disease, as a knowledge of the physical agents that favor or retard bacterial life will furnish indications for the preventive measures to be adopted. With a suitable soil and an adequate temperature, the propagation of bacteria proceeds with great rapidity. If the primary conditions of soil and an adequate temperature are not present, the organisms will not multiply; they remain quiescent, or they die. The surface layers of the soil harbor the vast majority of the bacteria, and constitute the great storehouse in nature for these forms of life. They lessen in number in the deeper layers of the soil, and few or none are to be met with at a depth of eight to ten feet. As a matter of fact, the soil is a most efficient bacterial filter, and the majority of the bacteria are retained in its surface layers and are met with there. In the surface soil, most bacteria find the necessary physical conditions for their growth, and may be said to exist there under natural conditions. It is in the surface soil that their main scavenging functions are performed. In the deeper layers, the absence of air and the temperature conditions prove inimical to most forms.

Among pathogenic bacteria the organisms of lockjaw and of malignant œdema appear to be eminently inhabitants of the soil. As an indication of the richness of the surface soil in bacteria, I may mention that one gramme of surface soil may contain from several hundred thousand to as many as several millions of bacteria. The air is poorest in bacteria. The favoring physical conditions to be met with in the soil are not present in the air. Though bacteria are to be met with in the air, they are not multiplying forms, as is the case in the soil. The majority to be met with in air are derived from the soil. Their number lessens when the surface soil is moist, and it increases as the surface soil dries. In a dry season the number of air organisms will tend to increase.

Town air contains more bacteria than country air, while they become few and tend to disappear at high levels and on the sea. A shower of rain purifies the air greatly of bacteria. The organisms being, as I stated, mainly derived from the surface of the ground, their number mainly depends on the physical condition of the soil, and this depends on the weather. Bacteria cannot pass independently to the air; they are forcibly transferred to it with dust from various surfaces. The relative bacterial purity of the atmosphere is mainly therefore a question of dust. Even when found floating about in the air, the bacteria are to be met with in much greater number in the dust that settles on exposed surfaces, e. g., floors, carpets, clothes, and furniture. Through a process of sedimentation the lower layers of the air become richer in dust and bacteria, and any disturbance of dust will increase the number of bacteria in the air.

The simple fact of breathing does not disseminate disease germs from a patient; it requires an act of coughing to carry them into the air with minute particles of moisture. From the earliest times great weight has been laid upon the danger of infection through air-borne contagia, and with the introduction of antiseptic surgery the endeavor was made to lessen this danger as much as possible by means of the carbolic spray, etc. In the same connection, numerous bacteriological examinations of air have been made, with the view of arriving at results of hygienic value. The average number of micro-organisms present in the air is 500 to 1,000 per 1,000 liters; of this number only 100 to 200 are bacteria, and they are almost entirely harmless forms. The organisms of suppuration have been detected in the air, and the tubercle bacillus in the dust adhering to the walls of rooms. Investigation has not, however, proved air to be one of the important channels of infection. The bactericidal action of sunlight, desiccation, and the diluting action of the atmosphere on noxious substances, will always greatly lessen the risk of direct aerial infection.

The physical agents that promote the passage of bacteria into the air are inimical to their vitality. Thus, the majority pass into the air, not from moist, but from dry surfaces, and the preliminary drying is injurious to a large number of bacteria. It follows that, if the air is rendered dust-free, it is practically deprived of all the organisms it may contain. As regards inclosed spaces, the stilling of dust, and more especially the disinfection of surfaces liable to breed dust or to harbor bacteria are more important than air disinfection, and this fact has been recognized in modern surgery. In an investigation, in conjunction with Mr. Lunt, an estimation was arrived at of the ratio existing between the number of dust particles and bacteria in the air. We used Dr. Aitken's dust-counter, which not only renders the dust particles visible, but gives a means of counting them in a sample of air. In an open suburb of London we found 20,000 dust particles in one cubic centimeter of air; in a yard in the center of London about 500,000. The dust contamination we found to be about 900 per cent greater in the center of London than in a quiet suburb. In the open air of London there was, on an average, just one organism to every 38,300,000 dust particles present in the air, and in the air of a room, among 184,000,000 dust particles, only one organism could be detected.

These figures illustrate forcibly the poverty of the air in micro-organisms, even when very dusty, and likewise the enormous dilution they undergo in the atmosphere. Their continued existence is rendered difficult through the influence of desiccation and sunlight. Desiccation is one of nature's favorite methods for getting rid of bacteria. Moisture is necessary for their development and their vital processes, and constitutes about 80 per cent of their cell-substance. When moisture is withdrawn, most bacterial cells, unless they produce resistant forms of the nature of spores, quickly succumb. The organism of cholera, air-dried in a thin film, dies in three hours. The organisms of diphtheria, typhoid fever, and tuberculosis show more resistance, but die in a few weeks or months.

Dust containing tubercle bacilli may be carried about by air currents, and the bacilli in this way transferred from an affected to a healthy individual. It may, however, be said that drying attenuates and kills most of these forms of life in a comparatively short time. The spores of certain bacteria may, on the other hand, live for many years in a dried condition, e. g., the spores of anthrax bacilli, which are so infective for cattle and also for man (wool-sorter's disease). Fortunately, few pathogenic bacteria possess spores, and therefore drying, by checking and destroying their life, is a physical agent that plays an important role in the elimination of infectious diseases. This process is aided by the marked bactericidal action of *sunlight*. Sunlight, which has a remarkable fostering influence on higher plant life, does not exercise the same influence on the bacteria. With few exceptions, we must grow them in the dark in order to obtain successful cultures; and a sure way of losing our cultures is to leave them exposed to the light of day. Direct sunlight is the most deadly agent, and kills a large number of organisms in the short space of one or two hours; direct sunlight proves fatal to the typhoid bacillus in half an hour to two hours, to the diphtheria bacillus in half an hour to one hour, and to the tubercle bacillus in a few minutes to several hours. Even anthrax spores are killed by direct light in three and a half hours. Diffuse light is also injurious, though its action is slower. By exposing pigment-producing bacteria to sunlight, colorless varieties can be obtained, and virulent bacteria so weakened that they will no longer produce infection. The germicidal action of the sun's rays is most marked at the blue end of the spectrum; at the red end there is little or no germicidal action. It is evident that the continuous daily action of the *sun*, along with *desiccation*, are important physical agents in arresting the further development of the disease germs that are expelled from the body.

It has been shown that sunlight has an important effect in the spontaneous purification of rivers. It is a well-known fact that a river, despite contamination at a given point, may show little or no evidence of this contamination at a point further down in its course. Buchner added to water 100,000 colon bacilli per cubic centimeter, and found that all were dead after one hour's exposure to sunlight. He also found that in a clear lake the bactericidal action of sunlight extended to a depth of about six feet. Sunlight must therefore be taken into account as an agent in the purification of waters, in addition to sedimentation, oxidization, and the action of algæ.

Air or the oxygen it contains has important and opposite effects on the life of bacteria. In 1861 Pasteur described an organism in connection with the butyric acid fermentation, which would only grow in the absence of free oxygen. And since then a number of bacteria, showing a like property, have been isolated and described. They are termed anærobic bacteria, as their growth is hindered or stopped in the presence of air. The majority of the bacteria, however, are ærobic organisms, inasmuch as their growth is dependent upon a free supply of oxygen. There is likewise an intermediate group of organisms which show an adaptability to either of these conditions, being able to develop with or without free access to oxygen. Pre-eminent types of this group are to be met with in the digestive tract of animals, and the majority of disease producing bacteria belong to this adaptive class. When a pigment-producing organism is grown without free oxygen, its pigment production is almost always stopped. For anærobic forms, N and H_2 give the best atmosphere for their growth, while CO_2 is not favorable, and may be positively injurious, as, e. g., in the case of the cholera organism.

The physical conditions favoring the presence and multiplication of bacteria in water under natural conditions are a low altitude, warmth, abundance of organic matter, and a sluggish or stagnant condition of the water. As regards water-borne infectious diseases, such as typhoid or cholera, their transmission to man by water may be excluded by simple boiling or by an adequate filtration. The freezing of water, while stopping the further multiplication of organisms, may conserve the life of disease germs by eliminating the destructive action of commoner competitive forms. Thus, the typhoid bacillus may remain frozen in ice for some months without injury. Employment of ordinary cold is not, therefore, a protection against dangerous disease germs.

As regards *electricity*, there is little or no evidence of its direct action on bacterial life, the effects produced appear to be of an indirect character, due to the development of heat or to the products of electrolysis.

Ozone is a powerful disinfectant, and its introduction into polluted water has a most marked purifying effect. The positive effects of the electric current may therefore be traced to the action of the chemical products and of heat. I am not aware that any direct action of the X-rays on bacteria has up to the present been definitely proved.

Mechanical agitation, if slight, may favor, and if excessive may hinder bacterial development. Violent shaking or concussion may not necessarily prove fatal so long as no mechanical lesion of the bacteria is brought about. If, however, substances likely to produce triturating effects are introduced, a disintegration and death of the cells follows. Thus, Rowland, by a very rapid shaking of tubercle bacilli in a steel tube with quartz sand and hard steel balls, produced their complete disintegration in ten minutes.

Bacteria appear to be very resistant to the action of *pressure*. At 300 to 450 atmospheres putrefaction still takes place, and at 600 atmospheres the virulence of the anthrax bacillus remained unimpaired. Of the physical agents that affect bacterial life, temperature is the most important. Temperature profoundly influences the activity of bacteria. It may favor or hinder their growth, or it may put an end to their life. If we regard temperature in the first instance as a favoring agent, very striking differences are to be noted. The bacteria show a most remarkable range of temperature under which their growth is possible, extending from zero to 70 deg. C. If we begin at the bottom of the scale, we find organisms in water and in soil that are capable of growth and development at zero. Among these are certain species of phosphorescent bacteria, which continue to emit light, even at this low temperature. At the Jenner Institute we have met with organisms growing and developing at 34 to 40 deg. F. The vast majority of interest to us find, however, the best conditions for their growth from 15 deg. up to 37 deg. C. Each species has a minimum, an optimum, and a maximum temperature at which it will develop. It is important in studying any given species that the optimum temperature for their development be ascertained, and that this temperature be maintained. In this respect, we can distinguish three broad groups. The first group includes those for which the optimum temperature is from 15 to 20 deg. C. The second group includes the parasitic forms, viz., those which grow in the living body and for which the optimum temperature is at blood heat, viz., 37 deg. C. We have a third group, for which the optimum temperature lies as high as 50 to 55 deg. C. On this account this latter group has been termed thermophilic, on account of its growth at such abnormally high temperatures—temperatures which are fatal to other forms of life. They have been the subject of personal investigation in conjunction with Dr. Blaxhall. We found that there existed in nature an extensive group of such organisms to which the term thermophilic bacteria was applicable. Their growth and development occurred best at temperatures at which ordinary protoplasm becomes inert or dies. The best growths were always obtained at 55 to 65 deg. C. Their wide distribution was of a striking nature. They were found by us in river water and mud, in sewage, and also in a sample of sea water. They were present in the digestive tract of man and animals, and in the surface and deep layers of the soil, as well as in straw and in all samples of ensilage examined. Their rapid growth at high temperatures was remarkable, the whole surface of the culture medium being frequently overrun in from fifteen to seventeen hours. The organisms examined by us (fourteen forms in all) belonged to the group of the Bacilli. Some were motile, some curdled milk, and some liquefied gelatine in virtue of a proteolytic enzyme. The majority possess reducing powers upon nitrates and decomposed proteid matter. In some instances cane sugar was inverted and starch was diastased. These facts well illustrate the full vitality of the organisms at these high temperatures, while all the organisms isolated grew best at 55 to 65 deg. C. A good growth in a few cases occurred at 72 deg. C. Evidence of growth was obtained even at 74 deg. C. They exhibited a remarkable and unique range of temperature, extending as far as 30 deg. of the Centigrade scale.

As a concluding instance of the activity of these organisms we may cite their action upon cellulose. Cellulose is a substance that is exceedingly difficult to decompose, and is therefore used in the laboratory for filtering purposes in the form of Swedish filter paper, on account of its resistance to the action of solvents. We allowed these organisms to act on cellulose at 60 deg. C. The result was that in ten to fourteen days a complete disintegration of the cellulose had taken place, probably into CO. and marsh gas. The exact

* Discourse delivered at the Royal Institution by Dr. Allan Macfadyen, Director of the Jenner Institute of Preventive Medicine.—Nature.

conditions that may favor their growth, even if it be slow at subthermophilic temperatures, are not yet known; they may possibly be of a chemical nature.

Organisms may be gradually *acclimatized* to temperatures that prove unsuited to them under ordinary conditions. Thus, the anthrax bacillus, with an optimum temperature for its development of 37 deg C., may be made to grow at 12 deg. C. and at 42 deg. C. Such anthrax bacilli proved pathogenic for the frog with a temperature of 12 deg. C., and for the pigeon with a temperature of 42 deg. C.

Let us, in a very few words, consider the inimical action of temperature on bacterial life. An organism placed below its minimum temperature ceases to develop, and if grown above its optimum temperature becomes attenuated as regards its virulence, etc., and may eventually die. The boiling point is fatal for non-sporing organisms in a few minutes. The exact thermal death-point varies according to the optimum and maximum temperature for the growth of the organism in question. Thus, for water bacteria with a low optimum temperature blood heat may be fatal; for pathogenic bacteria developing best at blood heat, a thermophilic temperature may be fatal (60 deg. C.); and for thermophilic bacilli any temperature above 75 deg. C. These remarks apply to the bacteria during their multiplying and vegetating phase of life. In their resting or spore stage, the organisms are much more resistant to heat. Thus, the anthrax organism in its bacillary phase is killed in one minute at 70 deg. C.; in its spore stage it resists this temperature for hours, and is only killed after some minutes by boiling. In the soil there are spores of bacteria which require boiling for sixteen hours to insure their death. These are important points to be remembered in sterilization or disinfection experiments, viz., whether an organism does or does not produce these resistant spores. Most non-sporing forms are killed at 60 deg. C. in a few minutes, but in an air-dry condition a longer time is necessary. Dry heat requires a longer time to act than moist heat; it requires 140 deg. C. for three hours to kill anthrax spores. Dry heat cannot therefore be used for ordinary disinfection on account of its destructive action. Moist heat, in the form of steam, is the most effectual disinfectant, killing anthrax spores at boiling point in a few minutes, while a still quicker action is obtained if saturated steam under pressure be used. No spore, however resistant, remains alive after one minute's exposure to steam at 140 deg. C. The varying thermal death-point of organisms and the problems of sterilization cannot be better illustrated than in the case of milk, which is an admirable soil for the growth of a large number of bacteria. The most obvious example of this is the souring and curdling of milk that occurs after it has been standing for some time. This change is mainly due to the lactic acid bacteria, which ferment the milk sugar with the production of acidity.

Another class of bacteria may curdle the milk without souring it in virtue of a rennet-like ferment, while a third class precipitate and dissolve the casein of the milk, along with the development of butyric acid. The process whereby milk is submitted to a heat of 65 deg. to 70 deg. C. for twenty minutes is known as pasteurization, and the milk so treated is familiar to us all as pasteurized milk. While the pasteurizing process weeds out the lactic acid bacteria from the milk, a temperature of 100 deg. C. for one hour is necessary to destroy the butyric acid organisms: and even when this has been accomplished there still remain in the milk the spores of organisms which are only killed after a temperature of 100 deg. C. for three to six hours. It will, therefore, be seen that pasteurization produces a partial, not a complete, sterilization of the milk as regards its usual bacterial inhabitants. The sterilization to be absolute would require six hours at boiling point. But for all ordinary practical purposes pasteurization is an adequate procedure. All practical hygienic requirements are likewise adequately met by pasteurization, if it is properly carried out and the milk is subsequently cooled. Milk may carry the infection of diphtheria, cholera, typhoid and scarlet fevers as well as the tubercle bacillus from a diseased animal to the human subject. For the purpose of rendering the milk innocuous freezing and the addition of preservatives are inadequate methods of procedure. The one efficient and trustworthy agent we possess is heat. Heat and cold are the agents to be jointly employed in the process, viz., a temperature sufficiently high to be fatal to organisms producing a rapid decomposition of milk, as well as to those which produce disease in man; this is to be followed by a rapid cooling to preserve the fresh flavor and to prevent an increase of the bacteria that still remain alive. The pasteurizing process fulfills these requirements.

In conjunction with Dr. Hewlett, I had occasion to investigate in how far the best pasteurizing results might be obtained. We found that 60 deg. to 68 deg. C. applied for twenty minutes weeded out about 90 per cent of the organisms present in the milk, leaving a 10 per cent residue of resistant forms. It was found advisable to fix the pasteurizing temperature at 68 deg. C. in order to make certain of killing any pathogenic organisms that may happen to be present. We passed milk in a thin stream through a coil of metal piping, which was heated on its outer surface by water. By regulating the length of the coil, or the size of the tubing, or the rate of flow of the milk, almost any desired temperature could be obtained. The temperature we ultimately fixed at 70 deg. C. The cooling was carried out in similar coils placed in iced water. The thin stream of milk was quickly heated and quickly cooled as it passed through the heated and cooled tubing, and, while it retained its natural flavor, the apparatus accomplished at 70 deg. C. in thirty seconds a complete pasteurization, instead of in twenty minutes, i. e., about 90 per cent of the bacteria were killed, while the diphtheria, typhoid, tubercle and pus organisms were destroyed in the same remarkably short period of time, viz., thirty seconds. This will serve to illustrate how the physical agent of heat may be employed, as well as the sensitiveness of bacteria to heat when it is adequately employed.

Bacteria are much more sensitive to high than to low temperatures, and it is possible to proceed much further downward than upward in the scale of temperature, without impairing their vitality. Some will even multiply at zero, while others will remain alive when frozen under ordinary conditions.

I will conclude this discourse by briefly referring to experiments recently made with the most remarkable results upon the influence of low temperatures on bacterial life. The experiments were conducted at the suggestion of Sir James Crichton-Browne and Prof. Dewar. The necessary facilities were most kindly given at the Royal Institution, and the experiments were conducted under the personal supervision of Prof. Dewar. The action of liquid air on bacteria was first tested. A typical series of bacteria was employed for this purpose, possessing varying degrees of resistance to external agents. The bacteria were first simultaneously exposed to the temperature of liquid air for twenty hours (about —190 deg. C.). In no instance could any impairment of the vitality of the organisms be detected as regards their growth or functional activities. This was strikingly illustrated in the case of the phosphorescent organisms tested. The cells emit light which is apparently produced by a chemical process of intracellular oxidation, and the phenomenon ceases with the cessation of their activity. These organisms, therefore, furnished a very happy test of the influence of low temperatures on vital phenomena. These organisms when cooled down in liquid air became non-luminous, but on re-thawing the luminosity returned with unimpaired vigor as the cells renewed their activity. The sudden cessation and rapid renewal of the luminous properties of the cells despite the extreme changes of temperature was remarkable and striking. In further experiments the organisms were subjected to the temperature of liquid air for seven days. The results were again *nil*. On re-thawing the organisms renewed their life processes with unimpaired vigor. We had not yet succeeded in reaching the limits of vitality. Prof. Dewar kindly afforded the opportunity of submitting the organisms to the temperature of liquid hydrogen—about —250 deg. C. The same series of organisms was employed, and again the result was *nil*. This temperature is only 21 deg. above that of the absolute zero, a temperature at which, on our present theoretical conceptions, molecular movement ceases and the entire range of chemical and physical activities with which we are acquainted either cease or, it may be, assume an entirely new role. This temperature, again, is far below that at which any chemical reaction is known to take place. The fact, then, that life can continue to exist under such conditions affords new ground for reflection as to whether, after all, life is dependent for its continuance on chemical reactions. We, as biologists, therefore follow with the keenest interest Prof. Dewar's heroic attempts to reach the absolute zero of temperature; meanwhile his success has already led us to reconsider many of the main issues of the problem. And by having afforded us a new realm in which to experiment, Prof. Dewar has placed in our hands an agent of investigation from the effective use of which we who are working at the subject at least hope to gain a little further insight into the great mystery of life itself.

BEES AND MATHEMATICS.

The construction of geometrically perfect cells is not the only mathematical operation performed by bees, according to Abraham Netter, who has just read an interesting paper on the subject before the Paris Academy of Sciences. The Revue Scientifique reports that he brought out the following facts:

"Not only is the construction of the cells carried on by mathematical rule, but many other operations of the insects also; for instance, the collection of the maximum amount of honey in the minimum time, and the division of the workers among the plants proportionally to the number of plants of the same species. In the hives, the number of bees engaged in ventilation is almost rigorously proportional to the daily increase of weight of honey, etc. Facts of this order relate to arithmetical proportion, while those having to do with cell-building relate to geometrical ratios."

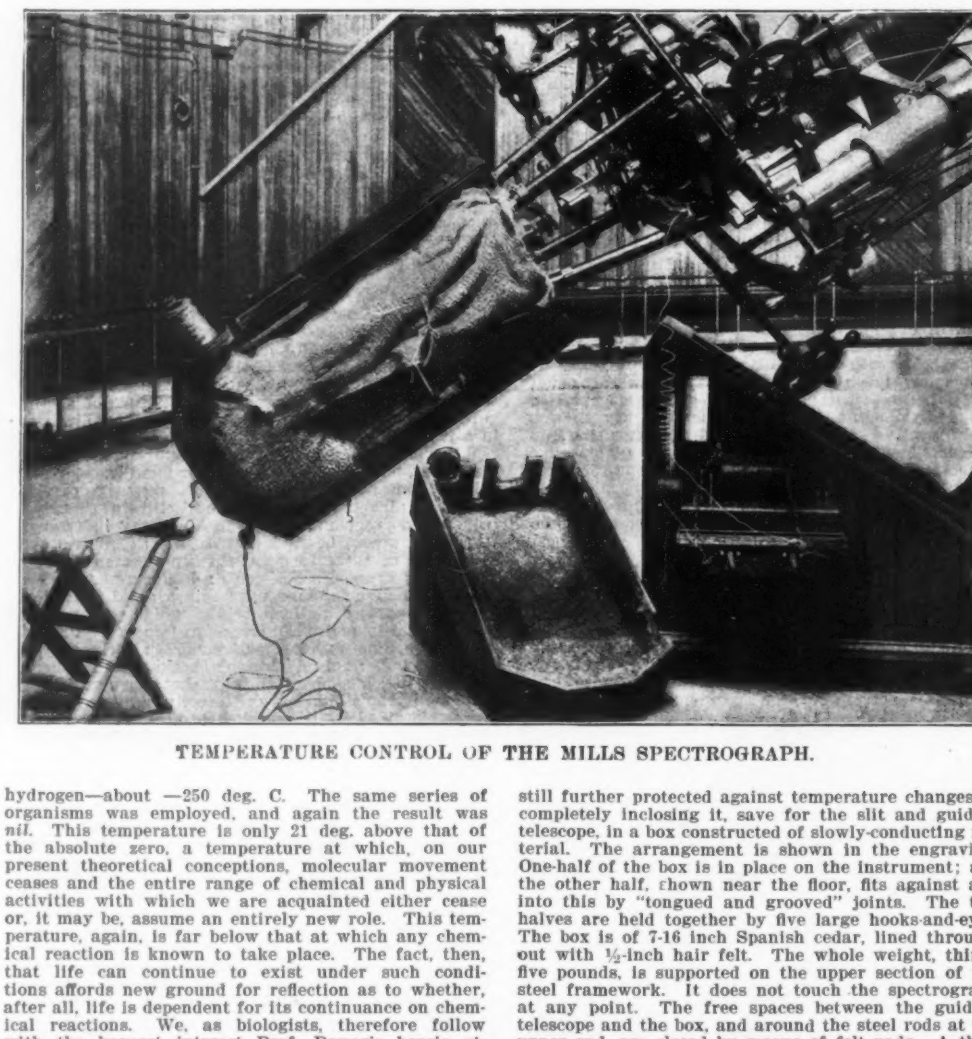
M. Netter is of the opinion, however, in spite of this show of apparent intelligence of the part of the bees, that "all their movements, without exception, are of the nature of reflexes;" that is performed without conscious action, just as we close our eyes instinctively when a motion is made toward them.—Translation made for The Literary Digest.

THE TEMPERATURE CONTROL OF THE MILLS SPECTROGRAPH.*

By W. W. CAMPBELL.

The great importance of the temperature factor in spectrographic investigations is recognized by all observers. Variations in the temperature of the apparatus, and especially of the dense prisms, during the progress of an exposure, affect both the definition and the deviation. As previously stated in The Astrophysical Journal (8, 140), the Lick Observatory is comparatively free from rapid changes of temperature. It is seldom, after 9 o'clock, that the thermometer readings in the large dome change a half degree Centigrade during exposures of an hour. In order to protect the Mills spectrograph, to a considerable extent, from irregularities in the atmospheric temperature, and from the heat of the observer's breath and body, the entire instrument was covered with two thicknesses of heavy gray woolen blanket, and the prism-box with four thicknesses. A large-scale thermometer was mounted with its bulb inside and near the middle of the prism-box. In a general way, the temperature of the air in the prism-box followed the temperature outside of the blankets; but the irregularities in the latter were rounded off in the former. The rate of change in the glass prisms themselves was probably even more uniform.

For more than a year past the spectrograph has been



TEMPERATURE CONTROL OF THE MILLS SPECTROGRAPH.

still further protected against temperature changes by completely inclosing it, save for the slit and guiding telescope, in a box constructed of slowly-conducting material. The arrangement is shown in the engraving. One-half of the box is in place on the instrument; and the other half, shown near the floor, fits against and into this by "tongued and grooved" joints. The two halves are held together by five large hooks-and-eyes. The box is of 7-16 inch Spanish cedar, lined throughout with ½-inch hair felt. The whole weight, thirty-five pounds, is supported on the upper section of the steel framework. It does not touch the spectrograph at any point. The free spaces between the guiding telescope and the box, and around the steel rods at the upper end, are closed by means of felt pads. A thermometer mounted on the inner surface of the box, and the thermometer in the prism-box can both be read through glass windows, to 1-25 degree Centigrade. A hinged door gives access to the plate-holder, and to the sliding diaphragm which controls the exposures on the brightest comparison lines. The woolen coverings remain in use as before.

German silver wire—B. & S. No. 29, 16½ feet in length each half of the box—is mounted near the surface of the felt. This wire is readily connected with a 10-volt storage battery, and furnishes the means of controlling a falling temperature.

Care is taken to ventilate the dome and spectrograph, during the day and early evening, so that at dark the readings of the thermometers in the prism-box, in the protecting box, and in the open dome, generally show a range of about 0.5 degree; and the reading in the dome will usually vary less than 2 degrees during the night. After the adjustments have been made, the spectrograph is inclosed in the blankets and in the box, and allowed to stand from fifteen to thirty minutes, until the temperatures in the prism-box and in the wooden case are partially equalized, before beginning an exposure. The equipment process is

* From the Astrophysical Journal published by the University of Chicago Press.

apparent from the fact that while the dome temperature is usually stationary or slowly falling, the temperature in the wooden case invariably rises to meet that of the prism-box.

The observer notes the reading of the thermometer in the wooden case—shown just above the guiding telescope—and endeavors to keep it constant by means of the electric current, which he controls with a switch near at hand. The temperatures in the case respond slowly to those outside, and rather rapidly to the influence of the current. Some irregularities necessarily exist in these temperatures; but their effects are rounded off before reaching the prism-box, and are scarcely appreciable.

The efficiency of the apparatus is illustrated by the following extract from the observing books, on a night when the temperature changes in the dome were unusually irregular. The readings were made at the beginning and ending of the exposures:

Plate number.	Limits of exposure time. Mt. Hamilton M.T. 1899, Aug. 29.	Temp. in dome.	Temp. in wooden box.	Temp. in prism-box.
1433 A	8h 28m	+17.9°C.	+18.4°C.	+188.4°C.
	10 02		18.9	18.80
1434 B	10 24	18.5	18.8	18.78
	11 00		19.0	18.80
1435 C	11 31		19.0	18.80
	13 07	17.2	19.0	18.80
1436 D	13 38		18.7	18.70
	15 15		18.8	18.70
1437 A	15 32		18.8	18.74
	16 09	19.0	19.0	18.74

An automatic control of the current could be arranged, but the need of it has not been seriously felt. Such a control should be independent of the variable component of gravity in the different positions of the instrument.

No provision has been made for reducing a rising temperature which sometimes occurs. It is possible that a spray of some volatile liquid within the wooden case would be efficient and practicable.

The use of this box and the controlling current has contributed appreciably to the accuracy of our line-of-sight determinations.

Acknowledgements are due to Mr. Wright for many of the ideas utilized; and to Professor Cory, of this university, who verified the computations for the thermal system and supplied the constants of the wire.

THE EXTINCT GIANT MOA OF NEW ZEALAND.

THE museum of natural history at Magdeburg, Germany, has added to its collection a specimen of the giant moa (*Dinornis*) of New Zealand. The moas, of which more than twenty species have been discovered, were huge birds closely related to the modern ostrich. In height they ranged from 4 to 15 feet. Their bodies were stout and their legs strong. Not only were they wingless, but possessed not even of rudimentary wingbones. According to Dr. Wolterstorff, in the Illustrirte Zeitung, moas inhabited New Zealand during the diluvial period—the glacial period of Europe—and were still to be found, though rarely, even after the advent of man. Moa bones are found in caves and swamps. It is difficult to state when the moas became extinct. It has been variously estimated that the last moa was killed several centuries before the first European appeared on the island. Certain it is that no European ever saw a living moa; and the Maori traditions, extending back some five hundred years, tell little or nothing.

The first moa-remains (a large, badly-preserved femur) were discovered in 1839 by Richard Owen, late director of the division of natural history of the British Museum. Other bones found later enabled Owen to study the bird minutely. Feathers and flesh were not discovered until 1871. The most important remains unearthed were eggs, a developed embryo, a fully-developed head in a fair state of preservation, and a foot.

Of the habits of the moa only conjectures can be formed. It seems certain, however, that the birds were not swift of foot, like our modern ostriches, but grubbers, and that with their stout legs they dug up the roots of New Zealand ferns, which constituted their chief source of nourishment. Although they fed on roots, it is probable that they did not despise grasshoppers and other insects. Like ostriches, the moas swallowed small stones to aid digestion.

Although many moa bones have been found (thousands are included in the British Museum collection), complete, mounted skeletons are rarely seen, for the reason that not all the bones can be readily obtained. Only the New Zealand provincial museum, the London museum, and the Viennese museum have series of skeletons. The Magdeburg museum but recently acquired the skeleton pictured in our illustration.

SPINNING FLIES.

AMONG the few insects capable of spinning in the imago state are certain little pseudo neuropterous flies of the family Psocidæ. Some insects of this family are wingless throughout life, and of these the little book lice, which are commonly seen running over paper, are known by sight to most people. Those Psocidæ with which we are here concerned have not received any popular name. They are winged in the imago state, and are prettily colored little flies, of curious and pleasing appearance, living often gregariously on tree trunks, palings, etc., as well as among the foliage of trees. Their spinning habits have long been known. Westwood gives a statement communicated to him by Audouin, that the latter naturalist had observed a female winged Psocus weave a web over eggs which she had deposited in the depressions formed by the veins of leaves. Hagen (1861) says generally that the females cover their eggs with a tissue, so that they form flat silvery spots; and McLachlan (1867) states that the eggs are laid in patches on leaves, bark and other objects, the females covering them with a web. Further, in 1884, Packard mentions having observed Psocids lay eggs on leaves of lilac, pear and horse chestnut; and he states that they are covered with a flat, round web like the "cocoon" of a spider, though only about a line in diameter. The principal observations, however, are those of Pierre Huber, published in 1843, and based on two Psocids—one with wings of uniform color and the other with those organs spotted with brown. The first individual watched was on the upper side of a Cytisus leaf, in the depression formed by the midrib, where the creature was making a little shining white spot, oval in shape, and consisting, as was seen by means of a strong lens, of a great number of silken threads, placed closely together and variously crossed. On examining the leaf against the light the little satiny patch of web was found to cover six small eggs. Subsequently, on leaves of trees of various kinds Huber found many such patches, all covering clusters of from six to fourteen eggs. By placing several of the flies under glass vases, with leaves from the trees on which they were found, he saw them spin repeatedly, observing the whole process from the laying of the eggs to their final concealment by the completed silken covering.

Huber observed that individuals believed to be males were capable of spinning; and McLachlan has expressed the opinion that both sexes spin. The web, the latter naturalist remarks, is undistinguishable from that of spiders; and he adds that if a number of specimens be inclosed in a pill box it will be found at the end of several hours that the interior is traversed in all directions by numerous lines of web. This circumstance appears to have been noted also by S. F. Aaron in the case of Psocus sexpunctatus, caught near Philadelphia and taken home in paper boxes.

THE MOA SKELETON IN THE MAGDEBURG MUSEUM OF NATURAL HISTORY.

It was noticed by Huber that some clusters of eggs had in addition to the ordinary close fitting covering another protection, a little distance above the first, of less close tissue, or composed of stronger and longer threads placed parallel. This upper tent was closed on one side, but always open on the other; and Huber thought it might serve as a place of refuge for the mother. He mentions that the species with spotted wings always made for its own residence a sort of web composed of long parallel threads. Some of the individuals which thus lurked under a trellis of silk were believed to be males. The creatures had space beneath their coverings to move about a little, and they could easily escape when they wished to do so. According to McCook, Psocus purus in America makes a tubular tentlike web in crevices of bark, etc. Under this web the insect lives after the manner of a tube-weaving spider, and entomologists who wish to capture it have to push it out by pressing upon the tent. As to the purpose of these webs, Huber thinks that the lines may serve to warn the creature of the approach of enemies; but not to protect it from attack, for the tents were so frail that a gnat might almost break them. It is certain, he adds, that Psocids do not lie in ambuscade, like spiders, for they are not predaceous.

With regard to the position of the spinning organs, Huber has made it clear that the threads come from the mouth. He was at considerable pains in attempting to establish their exact source, but found observation difficult on account of the smallness of the flies and the rapidity of their movements. After placing some of the insects in glass tubes and following them with a strong lens, he was inclined to believe that the silk proceeded from the upper lip. Hagen, however, who examined the labrum, found no spinning organ there, and he suggests that it is probably situated in the tongue, a structure associated with the lower lip. Burgess has since found within the tongue a pair of peculiar organs—lingual glands, which open by a common duct into the mouth near the throat; and these are thought to be concerned with the spinning work. Other spinning imagines are found in the family Embiidæ, also Pseudoneuroptera, a small group of insects of moderate size, of no popularity, and imperfectly known even to entomologists. The creatures are said to be related in certain respects to Psocids; but they are dissimilar, having perhaps a slight resemblance to Termitids, or white ants, with which also they are supposed to have some relationship. The spinning faculty, though occurring in the perfect insect, is better known in the larvæ; and it has been observed, further, in a form regarded by McLachlan as the nymph. The precise period at which it is noted, however, is not of great importance, for there is no marked metamorphosis, the insect having much the same form throughout life. Lucas states that the larvæ of Embia Mauritanica are found under stones in small silken tunnels; and similarly those of Embia solieri are stated by Lucas and by Girard to be found in similar situations also in tunnels of silk.

A box in which some of the larvæ of the first named species had been placed in 1850 was forgotten till 1858, and when opened was found to have its walls clothed with fine white silk, forming circular tunnels, in which dead larvæ were lying. Another Embid, Oligotoma michaeli, found chiefly in a wingless, perhaps larval, condition in a hothouse among orchids, was observed by Mr. Michael to have made a large number of webs on the roots and stems of the orchids and of neighboring plants. These webs had the form of silken galleries. They were not perfect tubes, but more of the nature of coverings, protecting the creatures from above and permitting them to feed upon the surface of the plant on which the web rested. One individual spun a web on the side of a box in which it had been confined for two hours, and some time afterward the web had been so much extended that it attached the lid to the box. When the lid was removed the insect ran about with activity, "ever anon retreating into a small, loose silken den or tunnel it had woven for itself at the bottom of the box." A figure of this individual shows small undeveloped wings, so that it had perhaps passed the larval condition. McLachlan states that silken tunnels were spun by nymphs as well as larvæ of this species; but it has been suggested that the form regarded as the nymph may have been the adult short winged female.—Science Gossip.

[Continued from SUPPLEMENT, No. 1317, page 21112.]

INFORMATION CONCERNING THE ANGORA GOAT.*

THE weight and length of fleece.—The weight of the fleece is always a subject of inquiry and is a difficult question to answer, because of the controlling circumstances—such as climate, feed, care, and, above all, the degree of Angora blood in the animal. The briefest answer, and probably the best one that can be made in a general way, is that of Mr. C. P. Bailey, and is as follows:

Half-breed goats scarcely shear enough to pay for the shearing; three-fourths bred goats shear 1 to 1½ pounds, worth 15 to 20 cents; seven-eighths bred goats shear 2 to 3 pounds, worth 20 to 30 cents; fifteen-sixteenths bred goats shear 3 to 5 pounds, worth 30 to 40 cents.

He adds the important statement that the fourth cross, or fifteen-sixteenths, is the lowest grade that he would use exclusively for mohair.

It would be a difficult matter to state what is the average length of an annual fleece, but 10 inches would probably not be much out of the way. There is on record an account of mohair measuring 20 inches. Mr. U. S. Grant, of Oregon, reports a buck with a fleece 19 inches long. In the southern part of the country, where shearing is done twice a year, the fiber must necessarily be shorter. This is a disadvantage, as the spinners prefer a long fiber. Schreiner shows (p. 119) a picture of a buck carrying a 13 months' fleece, weighing 16 pounds, which touches the ground. The feet of the animal are just visible.

The weights of the fleece in the United States are much greater than in Turkey and about the same as in the Cape of Good Hope. With reference to Turkey, Schreiner says: "It would seem that 14 pounds for rams and 8½ pounds for ewes are about the maximum weights of really first-class fleeces, and that if these weights are much exceeded the quality of the hair is inferior and a good deal of the weight is due to oil and dirt." In the Cape of Good Hope buck fleeces have surpassed 15 pounds and ewe fleeces 11 pounds. Information at hand indicates that the average weights of fleeces in Oregon exceed those of other sections of the country, especially in the warmer portions. This reminds one of the opinion of Colonel Black, that the fleece will be increased 1 pound in weight by moving the goats to the colder Northern States.

Kemp.—The term "kemp" used in connection with mohair refers, in a collective sense, to the coarse hair of the goats, and is especially noticeable in the lower grades. Hoerle says: "Kemp is the coarse, dead-looking hair all through the mohair, about 2 to 4 inches long, which I consider to be the degenerated remnants of the long, coarse, dead-looking outer coat of some common goats. It is usually thickest on the hind quarters of badly bred goats." Its presence in mohair always reduces the price in proportion to the amount that is present. The reasons for this are various—the hair is coarser than the mohair; it is lusterless; it is of various short lengths and must be removed, in doing which there is a heavy loss of mohair; and it will not, except to a limited degree, take the dyes used for mohair. This last statement is a striking fact and ought to be the means of prompting the mohair growers to strive to breed it out. Whether or not it can be done entirely is an open question, but it is believed by many prominent breeders that it can be done. Schreiner, however, considers kemp a part of the fleece that cannot be eradicated completely.

After the mohair sorter has done his work with a

* By George Fayette Thompson, Editorial Clerk, Bureau of Animal Industry. Abstract of Bulletin 27 of the Division of Animal Industry, Department of Agriculture.

fleece the fiber is scoured, dried, and straightened, and then put upon a combing machine. This machine separates all fibers, whether of kemp or mohair, of 4 inches in length and under. Kemp of a greater length than 4 inches remains with the longer mohair. If there is much of this long kemp after the first combing, the fiber passes through a second combing, the machine being set to throw out the kemp and mohair of greater length.

The residue of these two combings, being a mixture of kemp and short mohair, is called noilage. The first lot of noils is about 2 inches long and the second 4 or more inches long. The length of the second noils will vary with different grades of mohair, depending upon the length of the kemp present.

Some mohair will shrink 40 per cent in weight in the first combing and 15 per cent in the second. The mohair thus combed is used in the fabrication of plushes and fine dress goods, while the noils go into the manufacture of carpets, blankets, hats, etc.

Other deleterious features.—The very short hair, mane, kemp, and the hair that has been cut twice in shearing are, together, called noils, and this must all be combed out before the mohair can be spun. The noilage in Turkish mohair is only 15 to 20 per cent. In our domestic product it runs as high as 40 per cent. Noils are worth only 14 to 16 cents a pound, the same as short wool for blankets.

In some sections of our country, where the climate is dry and the soil distinctly alkaline, the natural animal yolk disappears from the mohair, leaving it dry, frowsy, and harsh. The dust of the fine alkali soil penetrates the fleece, so that much of the mohair grown in those sections is loaded with it, amounting in some instances to 40 per cent in weight.

Markets and factories.—Two of the questions which the mohair producers were asked to answer were: "Do you have any difficulty in disposing of your mohair?" and "Where do you market your mohair?" The answers to the first question were all firmly in the negative except in one instance, where an Arizona producer replied: "I have no difficulty in disposing of my good mohair, but my short and kempy stock goes slow and at a low price (23 cents)." There is much encouragement in these replies to those who may fear that the markets may not demand the supply. The ingenuity of the manufacturers in working the better grades into woolen fabrics and the poorer grades into plushes which make good car seats, horse blankets, hats, etc., has, no doubt, opened the way for the consumption of all that may be produced.

As to factories, there are more than a sufficient number in this country to manufacture the product; in fact, many of them do not attempt to use mohair for the reason that the supply is so limited. These factories of the United States are all in the East, and the principal market for the mohair is New York. The marketing center of the world is Bradford, England, where practically all the product of Cape of Good Hope and Turkey is sold.

Very few of the mills will purchase direct from the producer. They find it preferable to buy from the commission merchant, as he separates and classifies the fleeces, and the purchaser is enabled to make personal inspection. A few producers ship their mohair to Boston, and others, especially some of those in the Northwest, sell to commission men in Portland, while others of the West sell in San Jose, Cal.

Production.—The production of mohair will be considered elsewhere in connection with the world's production and the imports and exports.

Manufactures of Mohair.

One of the reasons why the mohair industry has lagged so in this country during the fifty years since the introduction of Angora goats is that the use of mohair goods was subject to the caprices of fashion. It would not be strictly correct to say that the industry has even got beyond the influence of fashion, but it is at least nearly so. There is now a steady demand for the product of our country, and much is imported besides. Dame Fashion is still whimsical toward all mohair goods, especially dress goods, but the mohair is mixed with other fibers for producing fabrics of strength and luster, and the home supply is not nearly equal to the demand. Because of the limited and uncertain supply, some mills which have at times used mohair no longer attempt to secure it. They are prepared to use it as soon as the supply will warrant the undertaking.

Mr. George E. Goodall, president of the Sanford Mills, Sanford, Me., who has kindly furnished the Bureau with valuable information, states that his mills consumed 840,000 pounds of domestic mohair and 460,000 pounds of Turkish mohair in 1899, a total amount of 1,300,000 pounds. While these mills are believed to be the largest consumers of the domestic product, there are thousands of pounds consumed by other mills. This proves, first, that there is a good demand for mohair, and second, that the usual estimate of the domestic production in 1899 as being between 600,000 and 800,000 pounds is far below the real amount.

Only a small percentage of the domestic product of mohair is of superior quality, as has been shown in previous pages. The greater amount is of inferior quality from various causes: First, the fleece from the crosses, beginning with the first cross, is called mohair, and is indeed worth something; second, all of the crosses up to the fourth or fifth have a great deal of kemp in the fleece (it never disappears entirely from any cross); third, efforts have been directed too persistently toward producing a large fine-looking animal, the fleece being a secondary consideration; fourth, the staple, when of superior quality, is often too short.

Many grades of mohair are mixed with silk and wool in a large variety of fabrics in which it formerly was not used. It is made into dress goods known as mohair, and much of what is usually called alpaca is nothing less than mohair. The fine fabric called camel's-hair goods is also of the best mohair, and not from the camel, as we would suppose from its name. "Chamal" is the Arabic word for camel, and the Arabs called the Angora goat the chamal. Mohair braids contest the markets with silk braids and are never out of fashion. The ways in which it is used with silk and wool are numerous. It adds to these fibers not only its brilliant inherent luster, but great durability as well. The growers of mohair are fond of quoting Dr. Davis, who stated in the Agricultural Report for 1853 that "I have socks [of mohair] which I have worn for six years and are yet perfectly sound." He is also quoted as saying that while in Asia he saw wrappers of mohair used by the natives which, they assured him, had descended from sire to son for three generations.

The Meat and the Markets.

The Meat.—In building up a flock of Angoras from common goats (a subject which is discussed elsewhere) the males must not be permitted to grow into bucks of breeding age; and even among the high grades there are comparatively few bucks that should be retained as such for breeding purposes. They should be castrated early. The great majority of these wethers, especially if they are of the first or second cross, do not produce sufficient mohair of good quality to warrant flock raisers in keeping them. These should be converted into meat as soon as large enough. Those wethers and does which produce a fair quality of mohair may be retained for that purpose for a few years and then killed for meat. They are not, however, so good for this purpose as the younger animals.

There is a deep-seated prejudice, as has already been stated, against the use of goats of any kind for meat. This is founded upon ignorance rather than experience. The most ill-smelling "billy" of the worst possible type is by many made the standard of goat meat for the whole of the goat family. As far back as Abraham's day we read of goats being used for meat (very likely Angoras), and this, too, when there were many cattle and sheep. Certainly no prejudice existed against them at that time.

There is not much to be said about the meat of the common goat. It is not so generally used as that of Angoras. The flesh of their kids is considered very fine, and in some sections of the country goats of all ages are killed for meat. There are comparatively few common goats in the United States, and no attempt is being made to put them upon the market. The current report that goats are sold to the packers in the large cities for canning purposes is true in the main, but refers to the Angora grades. The discussion of this question in this paper deals with the Angoras of all grades.

The flesh of the Angora is exceedingly nutritious and palatable. Shropshire lambs, which are considered as among the best kinds of meat, are said not to be superior to a well-fed and well-cooked kid. In the Southwest these animals are as readily sold for meat as sheep, and the market has never been overstocked. A gentleman in Texas found a ready market for his canned Angora mutton, but was compelled to close his cannery because the supply of goats was not nearly sufficient to supply the demand. In the Northwest the principal use of the Angora is for clearing bushy land, and consequently they are not so extensively used as food. However, in nearly every locality there some have been killed for mutton, and there has never been a derogatory statement concerning its quality, so far as the writer is able to learn.

In Cape Colony it is said that the old does are slaughtered to furnish meat for farm hands and young wethers are sold to butchers in the town. In California many miners purchase Angora wethers in preference to sheep wethers for salting down for winter use, because, as they state, the Angora contains less fat, is more easily kept, and is just as palatable.

The Skins.

The use of Angora skins, other than for robes, rugs, and trimmings as described below, is not very extensive. The skin is of a more delicate constitution than that of the common goat, and so does not make such tough leather. While the skin may be taken as an item of salvage from an animal that has died or been killed for meat, it would not be profitable to raise them for leather alone. If such skins happen to have a good fleece upon them, they will be worth more for robes or rugs, but even then they would not be profitable alone. There must be other sources of profit in addition to the skins. Angora skins are manufactured into morocco for use in binding books, and excellent gloves are made from them which bring from $1 to $1.50 per pair.

An impression is widespread, based upon immature consideration, that Angora skins may soon supplant the great number of goatskins which we now import for leather, but the quality of the skin precludes any such possibility.

Hides should be kept clean and should be dried in the shade; sun-dried hides are worthless. If the skins are to be tanned soon after being removed, they may be salted. If they are not to be tanned soon, they should be dried.

Robes, Rugs and Trimmings.

Angora pelts are used quite extensively as carriage robes, and they make up into very handsome ones. There was a time when the buffalo, the wolf, and other wild animals supplied the demand for robes in this country, but the extinction, practically, of the buffalo and the great scarcity of the other animals has forced us to look elsewhere for substitutes. An effort is being made to substitute hides of the Galloway and Polled Angus breeds of cattle, but their high cost will prevent their extensive use.

These conditions have resulted in a greater demand for Angora skins for robes. The skin is sufficiently tough for the purpose, and the fleece is easily dyed any desirable color. This characteristic has enabled unscrupulous dealers to sometimes pass them off on purchasers as the skins of some rare animals. In their natural color, the whiteness and brilliancy of which cannot be excelled, the skins of the kids and younger does are made up into robes for baby carriages. There are probably a greater number used for this purpose at the present time than in any other way.

As a general statement it may be said that Angora pelts are worth from $2 to $3. The real value depends upon many things—such as the size of the skin, the length of the fleece upon it, and the time of year that it is taken.

As rugs these skins are found in many households, and they are both ornamental and durable. They may be used in their original whiteness, or be dyed any color to suit. Their softness makes them very desirable.

They are extensively used for trimming for children's cloaks and coats. Some first-class skins have brought as high as $18 apiece for this purpose.

Mr. William R. Payne, of New York city, who has had much experience in handling goatskins, says:

Angora skins properly dressed are used, white or tinted, to manufacture rugs, robes, carriage mats, fur sets for children, trimming for ladies' furs, and also for dusters, horse head tassels, doll hair, and wigs. They are mostly imported raw from Cape of Good Hope and Turkey, and range in value, duty paid, from $1.50 up to $3.50 each, undressed. Domestic skins are worth from 50 cents for kids up to $2 each for large full-fleeced pelts. The low, crossbred, common skins and short pelts not suitable to dress are used by morocco and glove leather manufacturers, and are worth from 15 to 18 cents a pound for l rge sizes down to 10 and 11 cents for small ones and kids.

Protection for Sheep.

The ability and inclination of the buck to fight varmints has made him in many places a valuable acquisition in herds of sheep. It is said that dogs and wolves will not only not attack a grown goat, but will not venture into a herd of sheep where there is a buck goat. Many owners of sheep in this country recognize the value of the goat in this respect, and keep one or more for the purpose of protection for their sheep. This practice is especially desirable in pastures where there is no herder or immediate oversight. If one or two goats are placed when young in a herd of sheep they will remain with them all the time. An extensive breeder of Pennsylvania says: "While goats do not fear dogs, and will even fight, I prefer to keep dogs out. I have seen them drive a dog out of the yard, and oftentimes a single goat will protect a flock of sheep from attacks by dogs." If they are old and not accustomed to being with sheep, they will in all probability keep to themselves, away from the sheep. They may be depended upon to do this certainly if there is quite a number of them. They are more rapid walkers and more inclined to wander than sheep, and so will flock by themselves. Their protection to sheep will thus prove a failure.

Enrichment of Land.

The enrichment of land from the droppings of goats is decidedly noticeable wherever they are kept for a year or more. This factor is of no small importance where goats have been employed to clear the brush from land with the object in view of turning the land into grass pasture. Such land, especially if hilly and rocky, is usually in need of fertilizers of any kind if cropping is to be attempted upon it. The manure of goats and sheep is about equal in value. A California firm has been selling Angora manure for fertilizing fruit trees and lawns for several years. They get $6 a ton (delivered) for it in carload lots. Manure is considered as one of the resources in the best system of modern farming, and it should be taken into account by any one who is keeping goats or contemplating doing so.

Their Use as Pets.

The purebred Angoras are very graceful, and their beautifully shaped bodies and fine silky hair make them very attractive. There is no animal, except possibly the horse that is more beautiful than these goats, and no animal is more cleanly in his habits. As pets for children they are very popular, if they can be kept where they will be harmless to vegetation and anything made of cloth. They have all the propensities of the common goat for destroying fruit trees and chewing any kind of cloth and of climbing upon roofs. All kinds of goats are mischievous in the extreme. The Angoras are tractable and are often harnessed to carts, as are common goats, and their beauty makes them more desirable for this purpose.

By-Products.

In the modern methods of economic production and manufacture nothing is permitted to go to waste. Whoever it was that said facetiously that the packers saved every portion of a hog but his squeal spoke the whole truth. The same truth applies as well to the carcass of any food animal. In the case of goats the horns find many uses, and the fat is said to be the best tallow known for the manufacture of candles. Any part of the carcass not useful in any other way is converted into fertilizer.

THE OIL-FIELDS OF BAKU.

On approaching the Caspian Sea from any direction, the extent and importance of the oil production of Baku are pressed upon the attention. At Tashkend, 1,200 miles across the deserts to the east, Caspian crude petroleum is the fuel used in the locomotives, while far beyond that limit, camels and carts are loaded with the refined product for consumption in the more distant interior. All along this railroad of Central Asia, tank-cars for the transportation of oil make up a large part of the freight trains; while west of the Caspian the railroads to the Black Sea are fairly blocked with these unsightly vehicles. All the steamers on the Volga use the oil for fuel, and are busily engaged, while navigation lasts, in distributing it to the towns of central Russia. Indeed, the transportation of the petroleum product at Baku is an enormous problem. It is 560 miles to Batum, the nearest port for distribution on the Black Sea, and an elevation of more than 2,600 feet has to be surmounted to reach it. Up to the present time the Russians have not ventured to build a pipe line for pumping the oil that distance. They have depended entirely on a single railroad and on the Caspian steamers for the distribution of the enormous product. They have, however, just completed a pipe line, 143 miles long, down the west slope of the divide between the two seas, from Mikhailova to Batum. But the oil is still all transported from Baku, more than 400 miles in tank-cars.

As only about twenty-five million gallons a month has been delivered by this railroad, much of the product is shipped by a longer route, going by tank-steamers to Petrovsk, a port north of the Caucasus Mountains, and thence by rail around to Novorossisk, on the Black Sea, near the outlet of the Sea of Azoff. But as only ten million gallons a month are delivered by this route, the export of petroleum in 1899 was practically limited to 35,000,000 gallons per month. The actual exportation last year was from Batum 370,000,000 and from Novorossisk 51,000,000 gallons. Of this, 16,000,000 gallons went to Austria, 21 to Belgium, 28 to China, 30 to France, 30 to Germany, 48 to India, 12 to Italy, 5 to Japan, 9 to Java, 60 to the Suez Canal (in bulk), 20 to Turkey, and 85 to Great Britain. The total product of the Baku oil-fields in 1899 was 63,000,000 barrels, as against 49,000,000 barrels in America. In 1890 Baku produced only 38 per cent of the oil in the world, and in 1899 57 per cent. To one familiar with the oil-producing fields of Pennsylvania and Ohio, the small extent of this immensely productive area at Batum is astounding. There the productive centers are scattered over a good many thousand square miles; but here the production is mainly limited to three centers of a few square miles each. During the last twelve years a single twenty-acre lot has yielded 35,000,000 barrels of oil, and is still producing at the rate of 12,000 barrels per day. In 1898 13,000,000 barrels came from flowing wells.

The two main productive centers are within a few miles of Baku. The largest of these, about six miles to the north, covering an area of only seven square miles, has 8 flowing and 951 other productive wells. The total number at the close of 1899 was 1,028, with 598 more drilling. This concentration of the wells gives them a unique interest. The first view of the field makes the impression of a compact pine forest. This concentration, also, greatly facilitates the disposition of the crude oil. The refineries are all within a few miles, forming a strange city by themselves on the outer edge of Baku along the shore of the Caspian. There are hundreds of immense tanks in a bunch to hold the product, with pipes running along and across the streets in every direction. As there is considerable leakage from these, the streets literally flow with oil; and women and children come with rags to sop it up from the gutters, and with pails to carry it home or to market for sale. Only when the leaks are exceptionally large do the companies think it worth while to save this waste for themselves.

The Baku wells range from 500 to 1,500 feet in depth, averaging less than 1,000 feet. The geological formations through which they extend are much more recent than those penetrated by the wells in America, and much less compact. This gives rise to great difficulty in securing the production. So much sand works into the wells through the loose formation that it is impossible to use pumps to bring the oil to the surface. Resort, therefore, is had to a process of boiling. The wells are now frequently so large as to be tubed with 16-inch pipe. Down this pipe a boiler of nearly that diameter and forty feet long is dropped, attached to a wire cable. A boiler of that size brings up two barrels at a run, but the looseness of the rock renders it impossible in many of the wells to shut off the water, so that the extraction of the oil is much impeded on that account. Often when one boiler full of oil has been brought to the surface, two or three more runs must be made to clear the well of salt water which has filtered in while the oil was accumulating. Every imaginable device has been resorted to to remedy this evil, but without success. Liquid cement has been poured in to fill the cavity outside the tube, and then allowed to harden into a stratum impervious to water. But, as the oil-bearing stratum must be left open, the water eventually reaches it, and the two substances find their way together to the common receptacle.

This looseness of the superincumbent rocky strata leads to some interesting results which are different from those in America. Here, oftentimes, when a highly compressed reservoir is penetrated by the drill, there is nothing to prevent the escaping gas from tearing away the sides of the well and projecting the fragments into the air, like bowlders from a volcano. When, therefore, the reservoir has been once reached by the drill, the workmen flee for their lives, while the gas and oil and stones spout up high in the air, battering to pieces the derrick and overflowing the surrounding area with the oily mixture. The oil flows off in such a stream that dams of considerable dimensions are required to inclose the precious fluid, and huge pits are dug in which to store it. To learn all the particulars about this remarkable field, one should consult the sixteen annual reports of Mr. Chambers, the excellent American consul at Batum.

Like the oil-fields of America, those in Baku are really no new discovery, except in their extent. Long ago the crude Pennsylvania petroleum was sold all over the United States in small bottles for 25 cents, labeled Seneca Oil (from the name of the creek where it was chiefly obtained), and recommended as a cure for sprains and bruises and rheumatism. So abundant was this oil on some of the small streams in western Pennsylvania that it is said that when boys had been swimming in them their bodies were so slippery on coming out that it was impossible to keep their clothes on.

The Baku fields, however, have been known for thousands of years. There is here an ancient temple where Parsee priests kept a flame of natural gas burning from earliest times as a token of the special favor in which they were held by the Deity. Here pilgrim bands of fire-worshipers continue to resort, as the Moslems do to Mecca. But the fires in this temple are no longer kept living, except to gratify the curiosity of foreign travelers, for they are now completely outshone by the innumerable flames kept up for commercial rather than religious purposes. So great are these commercial interests that they have given an immense permanent increase to the wealth of the Russian possessions in the Caucasus, and have invested the Caspian Sea with an interest which it never had before. It is now one of the most important channels of internal commerce in the world.—G. Frederick Wright, in The Nation.

THE UNHAPPY ANTIQUITIES OF PALESTINE.

In England very little is known about the terrible devastations in the historic monuments of the nearer East, which are at present being perpetrated wherever that strange anomaly of these latter centuries—the Turkish government—holds sway, says The Builder. Palestine, as an archæological province, has been too much ravaged by powerful contending races all through its history to allow of any very complete monuments or monumental towns to survive from any particular period. But on its eastern border, across the Jordan, two or three very remarkable ancient cities survived as deserted ruins of the Roman period until a few years back. And they survived in a condition which was simply amazing both for intactness and monumental importance. Now, alas! they are almost quite cleared away by the newly invented and ingenious Turkish system of importing colonists into such regions, and selling them the sites of famous historic towns—the ruins of which are found to be admirably adapted as stone quarries. Two of these splendid old Romano-Greek cities call for special mention at the present moment—Gerasa (Geraen) and Ammân (Philadelphia), two cities of the Decapolis, or ten-city league of Classic times, on the east side of the Jordan, in the hill country which separates Palestine from the still unexplored Syrian desert. A reference to the plans published in Baedeker will show how important the buildings were which covered the city sites, and the numerous photographs which have been published at different times during the past twenty years (for instance, in L. Oliphant's "Land of Gilead") are sufficient evidence of the extraordinarily preserved details of theaters, temples, basilicas, and various public buildings which, until recently, remained in a state of untouched neglect which rendered such remains far more interesting than the Forum of Rome or the Acropolis of Athens.

Now, unhappily, these most interesting cities (like an unburied Pompeii) exist no more. The latest accounts from various travelers give the same sad result. Gerasa is occupied by a band of colonists from Bosnia (Mohammedans dissatisfied with an Austrian administration), and they are pulling down the Roman ruins wholesale, and the columns of the famous "street of columns" are being removed, to some extent, for the purpose of replacing the injured columns of the great Mosque of Damascus. The Roman masonry is otherwise being broken up to serve for garden walls and ordinary mud-hut architecture. The marvelously-preserved carving, which has survived fifteen centuries of Byzantine and Arab carelessness, is now being hacked off the squared stones in order to fit them for insertion in a Turkish "Kahn" or "hareem" wall. In Ammân the destruction of the classic city is even more complete; very few of the public buildings now remain, and the columns of the "street" are being thrown down for the purpose of breaking up into small pieces for inclosure walls. The "Circassians," as these colonists call themselves, act in a methodical manner, and they are gradually eating through the city. They employ the curious carts of Turkish peasants, with the solid wheels, for transporting the broken up remains. The famous theater of Ammân is now quite gone; the temples, in fact, the city, as a monument of the early centuries has completely disappeared, and the very few tourists who visited it during the past few years were privileged in seeing an extraordinarily preserved Classic town, which has since been swept away.

Nothing can now be done to preserve Ammân and Gerasa, but their fate suggests what threatens nearly all the most famous monumental remains in Turkey. Can anything be done to arrest the Turkish Destroying Angel (or perhaps we may say vulture)? The Turk has discovered that there is something to be made out of an increased population, and so he invites his co-religionists from the Balkans, the Caucasus, or Algeria—where they "suffer" the "persecution" associated with a Christian domination; and the deserted districts of Syria or Asia Minor, which teem with the monumental remains of past civilizations, afford an excellent squatting ground for these comparative savages. The promoters and prospectors of these colonies naturally seize on such sites as have the original advantage of good water, an air of former cultivation, and a ready-made quarry of old building stone. In this way we may conclude that, within a measurable time, all the most famous ancient sites will be converted into the more or less permanent settlements of the "Circassians," as these colonists are termed, whether they come from Algeria or Herzegovina. To the archæologists and historical students such a state of things is sufficiently deplorable, but what can be done? The case seems hopeless; still, an international protest might perhaps be set on foot to induce the Constantinople authorities to use some discretion in encouraging the wholesale destruction of the monuments of the different countries constituting the Ottoman Empire. The English archæological societies should surely not find such an enterprise outside the scope of their institution, and the Russian Imperial Archæological Institute would doubtless co-operate.

Much still remains in these countries to preserve and protect. Palmyra will be threatened before long; it possesses abundant water and heaps of old masonry suitable for building Circassian "houses." Surely it is worth while trying to preserve such a place.

The beginning of a transformation is taking place in Turkey. Bolstered up by the flattery and "moral support" of the European Powers, the warlike savagery of the race tamed by so many years of peace, and by the introduction of railways, telegraphs, and the general machinery of civilization, the modern Turks are displaying the first gleams of an intelligent desire to develop the resources of their country for their own benefit. Within the last year or two the Sultan has inaugurated this new system by laying claim to the whole valley of the Jordan and the whole of the Dead Sea as his personal property. Title deeds, or "cushans," are being rigorously inquired into on all hands, and the Mohammedan legal profession is in a fair way to become as important as the military system of former days. All the mineral riches of Palestine and Syria are now being jealously guarded as soon as discovered; and foreign enterprise, which is continually being offered for the development of these riches, is viewed with the utmost hostility. The English railway started to run from Haifa to Damascus some eight years ago has been nipped in the bud; and as part of this new system of setting the Mohammedan house in order, an influx of colonists is being encouraged from those fringes of the European world where Mohammedanism is recoiling from the distasteful manners and customs, and modern ideas, of civilization. Every steamer to Beyrout brings whole families of Algerines, Tunisians, or Albanians, and these people find their way inland and serve to swell the forces of Mohammedan obstructiveness against Western enterprise and influence. From any point of view except that of archæology such a state of things would be merely curious, but as it involves the destruction of some of the most interesting historical monuments ever erected, the disaster must be considered the greatest of the kind the world has seen, more especially considering that at the present day it ought to be so completely prevented.

The first suggestion for this new Turkish system of colonization probably originated in the days when the English sentiment for "restoring" the Jews to Palestine was at its height in the seventies and eighties. Even then the Turks, who looked upon the Jews as very unwelcome strangers, began to consider the advisability of meeting this unavoidable difficulty by the usual Oriental expedient of pitting one race against another, and so wherever the Jews were settled by foreign influence the Turks have started a "Circassian" colony. Cæsarea on the coast was one of the first to be founded, and the Roman ruins and the interesting remains of the crusading kingdom have been broken up to build the squalid "Circassian" huts with thatched roofs, and the rough walls of straggling gardens. And this is the last fate of the vestiges of that classic civilization which has been the theme of study and "renaissance" all through the centuries of the immediate past. How little Volney, De Vogüé, or Renan thought the interesting ruins they were so instrumental in recovering for European study would, within a comparatively few years, be sacrificed to the sordid greed and interests of a barbarous Turkish colonization.

TRADE IN THE SAHARA DESERT.

A large desert lies between the southern boundary of Algeria and the Sudan which, under the common name Tuat, embraces three districts—Gurara, in the north; Tuat proper, south of Gurara; and Tidikelt, east and southeast of Tuat. The last-named district is sparsely inhabited, but exercises a kind of sovereignty over both of the others. The oasis, Insala, the central point of Tidikelt, lately occupied by France, consequently involves control of all Tuat. The district embraces about 773 square miles; it has 203,000 inhabitants, 332 "ksour" (fortified villages or market places), and 7,000,000 palm trees. Although these "ksour" are situated in a land almost desert, producing only a few dates and plants, they are markets for the nomadic tribes. Insala, especially, is the market place for the Hoggar-Tauregs. The Moniteur Officiel du Commerce says that chiefly as the result of its geographical position, Tuat has developed a very considerable trade with the Sudan, particularly in European goods imported by way of Morocco or Tripoli. Two great caravans go yearly from Akabli, the most southern oasis of Tidikelt, to Timbuktu. The first caravan of the season starts early in April, reaches Timbuktu at the end of May, remains there during the summer months, and starts on the return journey on the 1st of October, arriving at Akabli by the middle of November. The second caravan leaves Akabli early in October and returns in May. Thirty-five days are sufficient for the journey, but the caravans take a few days more for the necessary rests. The resting places are selected with regard to springs of water, shade, and fodder. The caravans take to the Sudan firearms, swords, tools and hardware from Germany; cotton, cotton goods and muslins from Great Britain; glass-ware from Italy; from France—lace, yarns, needles, scarves, paper, soap, tobacco, knives, weapons, corals, perfumes, iron and copper wire, and medicines, besides dates and salt. In exchange they bring from the Sudan ostrich feathers, ivory, tanned hides, gold dust and baskets. They also bring slaves. Caravans have, on an average, 9,000 camels. In regard to the region south of Tunis, the Bulletin de la Société de Géographie Commerciale has an article, of which the following is a summary: "Djérid, properly speaking, comprises the region situated between the salt lakes of that name and the salt lake Kharsa, composed of the oases of El-Oudiane, El-Hamma, and Nefta, all remarkable for their great fertility. The population numbers some 30,000 inhabitants, mostly devoted to agriculture. The principal culture is the date-palm, which suits the soil admirably. To encourage its cultivation the government has suppressed the export duties on dates. There are 635,000 trees, every part of which can be utilized. The wood is used for carpentering, and to make beams and doors; the flexible ends of the young branches are planted on the walls of beaten earth, inclosing the oasis in a palisade. The young leaves are employed in basket work, in making hats, covers of plates, etc. The sap is utilized in making a drink much appreciated by the natives. The most important product, however, is the fruit, of which from 800 to 1,000 tons of one variety alone are annually exported, while the production of other kinds reaches 15,000 tons, a third of which is consumed in the country and the rest exported. Next to the date, in importance, comes the olive tree. Lusa, Sfax, and Djerba are surrounded by magnificent forests of olive trees, and the oasis of El-Oudiane has 25,000 trees, producing annually 13,200 gallons of oil. This oil formerly found a market in Southern Algeria. At present, Lusa, Mehdia, Monastir and Sfax have model oil manufactories which equal the best equipped manufactories of Provence, Italy, and Spain. More than 8,000 tons were exported in 1898. The oil is of irreproachable purity and extremely delicate in flavor; in fact, the greater part of it is put on the market as French oil. Besides the olive and date, peaches, apricots, pomegranates, bananas, oranges, lemons, and

grapes flourish, and the fruits are sent to the Algerian markets. An important trade is also carried on in silk tissues and tissues of silk mixed with other materials. The silk coverlets, the burnouses, and the silk masques have acquired a certain renown. The fact that trade was flourishing a century ago between Ghadames and Hefta shows how easy it would be to establish a commercial house at Nefta for the exchange of grains and manufactured articles for the wool, cattle, skins, ostrich plumes, and arms of the Southern tribes. Already the creation of the port of Sfax, and the railway from Sfax to Gafsa have been the starting point of a new era. The railway belongs to the Society of Phosphates of Gafsa. Its construction was one of the conditions of the grant, and it is finished for 150 miles. The Phosphate Company and the railway have built five large bridges. More than 200,000 tons of phosphate have been extracted.

THE MUSEUM OF ARTILLERY AT PARIS.

THE Museum of Artillery of Paris possesses a complete series of royal trappings from the time of Francis I. to that of Louis XIV. Although not as rich as the Armeria of Madrid, where armors of Charles V. or Philip II. may be seen by dozens, it nevertheless shows us fine specimens of those magnificent panoplies on which neither money nor pains were spared. The black coat of mail touched up with silver, that belonged to Henri II., is one of the finest examples of them. Along with the famous repoussé armor preserved at the Louvre, it is the most beautiful that exists at Paris. Those of Francis II., Charles IX., and Henri III. are remarkable by reason of their fine state of preservation. That of Henri IV. is more interesting still, in that it shows us his war costume. Three armors of Louis XIII. are to be seen. One of these is complete, both for man and horse. It is the only one belonging to French sovereigns that possesses its barbs. That was then an anomaly, since the defense of the horse had long before fallen into desuetude. Another armor of Louis XIII., of blackened steel, with huge thigh pieces imbricated like the tail of a crayfish, is still provided with its thick, bullet-proof breastplate. The weight of defensive armor was then enormous. Certain of their reinforcing pieces weighed more than sixty pounds. In fact, it was at the period at which armor was about to disappear that its weight became most massive. Thus it was that the learned, taking as a basis certain cuirasses or bucklers to which they were unable to assign a date, established the weight of the famous armor worn by the Crusaders. Archæological solecisms still exist in statues and paintings, and it is better not to speak of them. The densest ignorance in regard to these matters existed at the beginning of the last century. Thus, there was attributed to Godefroy de Bouillon a beautiful gilded, repoussé armor that came from the arsenal of Sedan and dates from the sixteenth century. It is worth a fortune. So, too, there was attributed to Joan of Arc a beautiful white armor for fighting on foot, since no one had taken the trouble to read its date of manufacture, 1515, engraved in the palm of the right glove. It is now known that it belonged to a Medici, probably Lorenzino, Duke of Urbin, and was the work of the Milanese armorer, Negroli. The Negrolis, of Milan, were then famous, and forged accouterments for all the sovereigns of Europe. The work of the old Missaglias, of whom the Negrolis were successors, is reckoned among the most valuable. The piece that we figure here is one of the finest of the Museum of Artillery. It is a Milanese armor, of which the fine flutings are of the same type as those of what are called "Maximilian" in honor of the German emperor who was so fond of war, jousts, and tournaments. Such armors, whether Milanese or Bavarian, date from the last part of the fifteenth, or first part of the sixteenth, century.

Certain armors of the museum are very interesting in that they show transitory types between the entirely smooth ones of the time of Louis XI. and those provided with flutings, that were in fashion under the reign of Charles VIII.

The museum, moreover, possesses a few beautiful archaic armors, among which, standing in the front rank, is one from the collection of Pierrefonds.

The museum presents, too, a complete series of all types, dating from about 1460 up to the time of Louis XIV. These are well arranged in the two lower halls. To the left are the armors of war, certain of which, perched upon barbed horses, composed what amateurs style the "great cavalcade." Unfortunately, the dummy horses and men, badly arranged and assembled, do not satisfy the eye. The only mounting that is entirely satisfactory is that of the jousting armor of Emperor Maximilian II. A large hammer-cloth, embroidered in the imperial colors, clothes the horse from ears to hoofs. A beautiful chanfrin, richly repoussé, and a mane barb of similar work complete the trappings of the animal. The man's armor leaves the arms and legs uncovered. The latter, in fact, had no need of iron defenses, because the jousting knight galloped along a barrier placed to his left, and that was about four feet in height. In order to prevent his knee from rubbing against this palisade, which separated him from his adversary, the knight's thigh was protected by a sort of steel sheath that was secured to the pommel of the saddle and was called a leg-guard. The breast and throat received extraordinary protection, since, in addition to being cuirassed, they disappeared to the left behind a huge armored shield, and to the right behind the very wide hilt of the lance when the latter was placed at rest. This armor of Maximilian II., which dates from 1550, gives a very good idea of the archaic form that was preserved for jousts and tournaments. If we observe the helmet, we see that it is a sallet differing very little from those worn a hundred years previous for war purposes.

ITALIAN BUCKLER OF THE MIDDLE OF THE SIXTEENTH CENTURY.

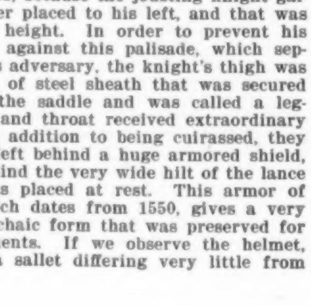
The museum is quite rich in jousting armors, especially German ones. Among those that belonged to celebrated persons may be mentioned that of the Count of Soissons (1570), that of the Duke of Bouillon (1575), that of the Duke of Guise (1580), that of Montmorency d'Amville (1575), that of the Duke of Mayenne (1590), and that of Sully (1615).

There exist some others which were once wrongly attributed to celebrated persons, but the actual ownership of which has since been ascertained. Errors in this regard are the more inexplicable, in that nothing is easier to ascertain the exact date of than that of an armor. In fact, the form of the latter is modeled exactly after the civil costume, of which it reproduces the exaggerations, the ornaments, the embroidery, and the lacework. The armors of the French kings are absolutely typical in this respect. Let us take, for example, those of the three Petits Valois: All three are light half-armors, the fundamental architecture of which is the same. All three are covered with engravings and are gilded; but the busk of that of Francis II. is not as arched, nor the haunches as salient, as those of his two brothers. In the armor of Henri III. these characteristics are still further exaggerated.

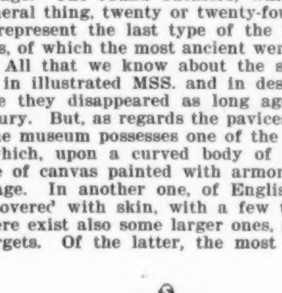
The most remarkable example of bad taste presented by a royal armor is furnished by that of Louis XIV., in which carefully etched historical pictures cover the entire surface of the steel, the whiteness of which has been preserved. This work was executed in 1668 by Franceso Garbagna, an armorer of Brescia. It is one of the last complete accouterments, with greaves and solerets, that was manufactured. Another armor of Louis XIV., worn when he was ten or twelve years of age, is certainly handsomer, and is the more remarkable in that it is almost like one that belonged to Louis XIII. These two iron armors must have been made by the same person, doubtless by Petit. This Petit (or these Petits, for it is believed that there were several of the name) turned out heavy and solid work. Their pieces sometimes reached formidable weights, certain of their strengthening pieces and their bucklers weighing more than fifty pounds. But they were objects of good workmanship, and were bullet proof.

Since we are speaking of bucklers, we may say that the museum possesses a very fine series of them, comprising nearly a hundred pieces, among which are thirty that are very beautiful objects of art, belonging to the sixteenth century, and of Italian or German workmanship. The one that we illustrate here reproduces the triumph of Galatæa. These magnificent bucklers were ornamental pieces that were carried in ceremonies before princes or other great persons. As well known, the buckler was long the emblem of captains of infantry. On a march, the officer had it carried by his page. The round bucklers, which measured, as a general thing, twenty or twenty-four inches in diameter, represent the last type of the series of defensive arms, of which the most ancient were shields and pavices. All that we know about the shields is what we find in illustrated MSS. and in descriptions in texts, since they disappeared as long ago as the sixteenth century. But, as regards the pavices, we are better off. The museum possesses one of the fifteenth century, in which, upon a curved body of wood, is pasted a piece of canvas painted with armorial bearings and foliage. In another one, of English make, the wood is covered with skin, with a few traces of painting. There exist also some larger ones, and likewise some targets. Of the latter, the most valuable

GERMAN JOUSTING ARMOR (END OF THE FIFTEENTH CENTURY.)



TOURNAMENT HELMET OF THE FIFTEENTH CENTURY.



HELMET OF HENRI II.

BURGANET OF HENRI II.

ITALIAN MORION (SIXTEENTH CENTURY).

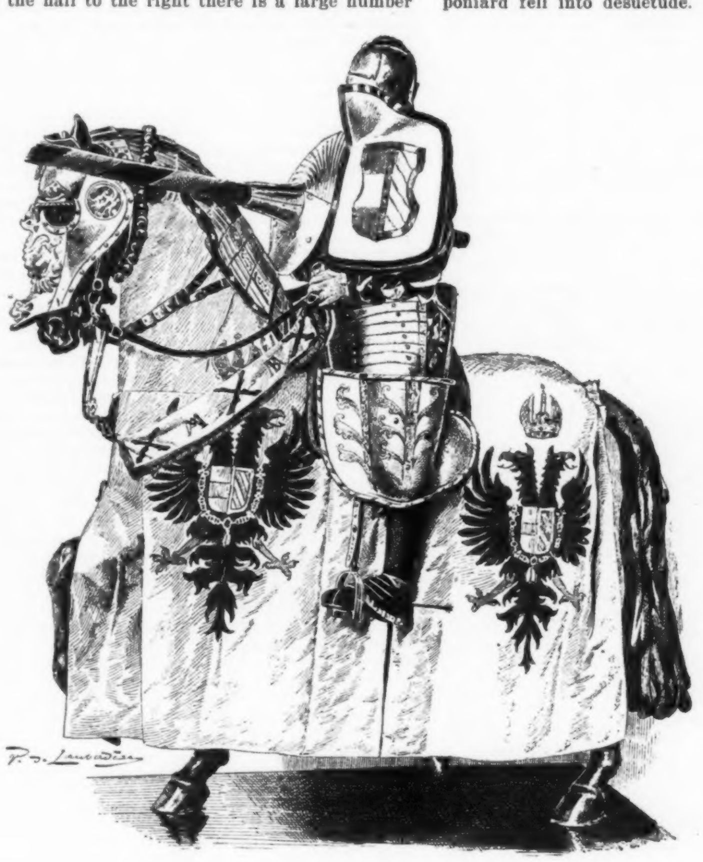
is one that belonged to Mathias Corvinus, King of Hungary. It therefore dates from the sixteenth century. It was doubtless stolen from the gallery of Ambras under Napoleon I.

The museum's collection of swords is extremely rich, consisting of battle and fencing swords, long rapiers, broadswords, sabers, etc., etc. Long rapiers, free from rust, abound in the museum. In the showcases in the hall to the right there is a large number of superb ones. Among others there is one with a basket-shaped, open-work hilt, of the finest steel, chased and carved in the most wonderful manner and forming a genuine piece of lace-work. This superb sword may be taken as a model of that Spanish art that shed its last light in the eighteenth century, for these beautiful rapiers are always more modern than is generally thought. The most archaic date back no farther than 1610, and the most modern to the reign of Louis XV. This form of sword was held in such honor in Spain that it became, as it were, the very emblem thereof. Thus, in the sumptuous portrait of young King Philippe V., painted by Rigaud, one of these rich rapiers of so characteristic form is seen alongside of the grandson of Louis XIV. One or two of these swords are reproduced in portraits just previous to the time of Velasquez. These rapiers did not go without their faithful and inseparable companion, the large poniard, with open-work hilt, spiral crossbars, and long blade. This was the last dueling weapon that was wielded with the left hand. In France, starting from the reign of Louis XIV., the poniard fell into desuetude. Fencing with the short sword abolished the use of it. The blows that could not be parried with the sword were arrested by the left hand, which was usually incased in a thick glove; and this fashion lasted for a long time. It is not until the time of the Restoration that we see an official proscription of this usage, which everything justified, but which in modern opinion is a felony. And we may ask why, since there was as much danger in parrying with the hand as there is in parrying with iron, and the conditions for the combatants were equal.

The rapiers more ancient than these basket or cup forms have their hilts elegantly turned into multiple branches, the curves of which show the master work of the smiths of times gone by. It would be almost impossible at the present day to find, outside of a few wonderful counterfeiters who work in secret to supply the great galleries, a workman capable of working upon the anvil and of welding these intertwinings of steel. Among all those of the museum, there is one sword of this kind that is particularly beautiful. It is doubtless the work of a Bavarian artist, perhaps of Hans Meilich. A tradition has it that this weapon belonged to Henri III. It is forged from the finest steel, into which are inlaid pieces of gold, which are carved into most delicate ornaments.

To return to the subject of armor, one of the finest specimens to be seen in the museum is what is called the "lion armor." Unfortunately, nothing much is known about this, except that it came from the arsenal of Sedan. It belonged either to a duke of Bouillon, or to a prince of the House of Savoy, as seems to be shown by the silver cross with which its breastplate is ornamented.

In default of other complete armors of like workmanship, the museum possesses more than one piece executed with equal skill. We figure here a Flemish fragment of the seventeenth century. It is a simple

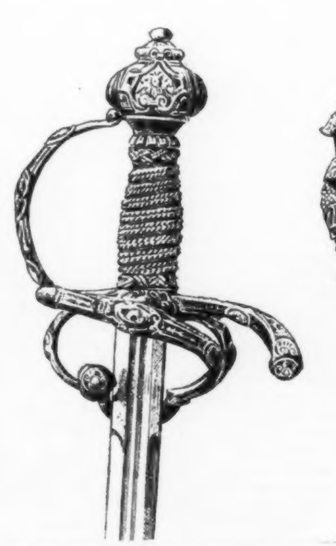


JOUSTING ARMOR OF MAXIMILIAN II. (1550).

ARMOR BY MASSAGLIA (BEGINNING OF THE SIXTEENTH CENTURY).

"LION ARMOR" (1560).

REMAINS OF A FLEMISH ARMOR (SEVENTEENTH CENTURY).



FRENCH SWORD (SIXTEENTH CENTURY).

ITALIAN DRESS SWORD (1560).

PISTOL WITH TWO BARRELS (SIXTEENTH CENTURY).

cuirass that has lost its shoulder pieces and its armlets and tasses, but has preserved its helmet, the ventail of which is grilled, according to a fashion that prevailed from the time of Henri III. until that of Louis XIII. If this armor were complete, it would be worth a fortune. It is made of thin steel, as was befitting an ornamental armor that was not to be worn in battle. The entire surface of the steel is in repoussé work, and the cuirass, like the helmet, is covered with ornaments and human figures, so delicately modeled that it would seem as if the unknown artist who did the work had wished to prove that at the very epoch at which the use of armor was disappearing, the armorers had attained the highest point that their art was capable of reaching.

The less decorated armors, such as those that the Germans of the fifteenth century wore to jousts or tournaments, are as wonderful as regards technique as the ornamental trappings are in their decoration. Burganets in the antique style, and repoussé morions, and engraved helmets are counted by hundreds. Thousands of other things belonging to the museum collection might be mentioned—maces and battle-axes, cutlasses, cimetars, broadswords, cinquedias (a sort of long poniard), and mixed weapons, in which a single or double barreled pistol is united with a hammer, sword, or some other blade.—For the above particulars and the engravings we are indebted to Le Monde Moderne.

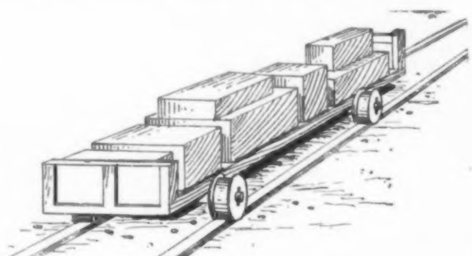
WOODEN RAILWAYS.

The mere idea of railways being made of wood is perhaps more likely to raise a smile of contempt now than to interest anyone, yet it is pretty certain they were the precursors of our modern steam roads. Wooden railways undoubtedly existed in or near Newcastle-on-Tyne as early as 1676, in which year Lord Keeper Guildford describes "the manner of carriage by laying rails of timber from the colliery, exactly straight and parallel." He goes on to say that "bulky carts are made, with rollers fitting those rails, whereby the carriage is so easy that one horse will bring down four or five chaldrons of coals." This quantity would be equal to from 10½ to 13¼ tons, exclusive of the vehicles, so it is plain the force of gravity deserved most of the credit. This fits the kind of country, the Tyne running through a valley of considerable depth. How the gage was preserved or the vehicles kept on the rails does not appear, but with sufficiently broad wheels, or rollers, and skill in managing the horse, they would keep on straight or slightly curved lines without much difficulty. Later on, in 1765, wooden railways are described as consisting of cross-pieces 6 to 8 inches square, 2 or 3 feet apart, upon which were fastened, with pegs, longitudinal squared timbers 6 or 7 inches wide by 5 deep. The great destruction of the cross-sleepers from the action of the horses' feet led to additional rails being laid on the top of the old ones, covering the joints in the latter. By this means the track could be well ballasted, while the whole structure was greatly strengthened and improved. Another and deeper set of timbers, laid inside the rails, served as a guiding flange. As thus laid, wooden railways continued to be used here and there till well into the nineteenth century, though most of them had been superseded by cast-iron tram-plates. All these lines were quite short, but Rees' Encyclopædia, written nearly one hundred years ago, mentions one 10 miles long, from the Tyne to Tanfield Moor. When the Middleton Colliery, near Leeds, was sold, in 1808, the plant included both iron and wooden railways, though possibly these were underground. Timber lines, however, were not entirely confined to the coal-producing districts of England, for in 1741 there existed a wooden railway at Prior Park, near Bath. It was for bringing down stone from the quarries on Combe Down, many of the beautiful buildings at Bath designed by the elder Wood being then in progress. It was nearly a mile long, falling sharply all the way. A brake of some sort was therefore required, and the account of it says: "To the rear part of the wagon was a contrivance by which a single man could check the motion, though heavily laden with large blocks of stone; which must have a great tendency to urge it forward." A drawing and short description, as shown, appeared in The Mechanic's Magazine for June 4, 1825, on what authority is not stated. John Smeaton, the celebrated lighthouse engineer of the eighteenth century, was perfectly familiar with wooden railways as common objects in his native district of Leeds. When preparing to commence the construction of the Eddystone lighthouse, in 1756, he laid out a system of wooden railways for conveying the rough stones from the landing-place to the mason's benches, and back again when dressed ready for shipping to the Eddystone Rock. The flanges of the wheels were on the outside, and to conveniently maneuver the small low trucks a number of turntables were used. Drawings of these railways may be found in Smeaton's account of the building of the lighthouse, published in 1793.

It is said that a wooden railway was put down near Sheffield so early as about 1714. Anyhow, one was certainly built there in 1774, possibly replacing the old line. It ran from the Duke of Norfolk's Manor Colliery downhill to the town—about a mile. The duke's agents, however, raised the price of coal to pay the cost of laying the line, and also refused to sell small quantities, as had been the practice before. This so enraged the Sheffielders that they tore up and burnt the line, together with the watch-house and office and the stage where the coal was dumped into carts at Sheffield. Several of the trucks were also burnt, one being run, when well alight, into the river. Soon after, the line was relaid with the first cast-iron flanged rails or tram-plates ever made, by James Outram, of Ripley Iron Works, in Derbyshire.

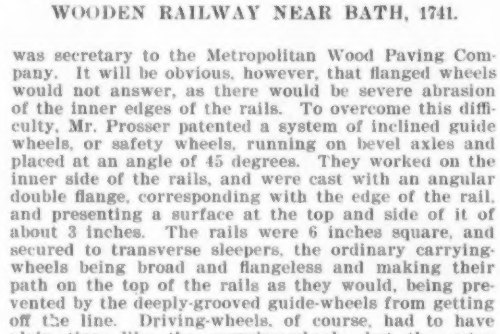
Long after this time—namely, in 1843—some remarkable experiments with wooden railways were made in and near London. A temporary line about 175 yards long, with gradients of 1 in 9, 1 in 25, and 1 in 100, and a curve in the middle of 725 feet radius, was put down. This was run over constantly for eight weeks by an engine built for the Albert Steam Carriage Company and intended for road traction, under Squire's patent. The rails were of beech, or Scotch fir, possibly both kinds, treated by Payne's process. Sulphate of iron was forced into the wood, and then carbonate of soda, resulting in its becoming very hard and solid. The engine weighed only about three tons in working order, of which two tons rested on the driving-wheels. On the rise of 1 in 25, with only one driving-wheel in gear, it took up fifteen men and two boys without slipping, though the rails were wet. Wonderfully little wear was visible at the end of the time, some saw-marks even not being obliterated. The engineer of the line in question, which was on the Pimlico side of the river Thames, was Mr. John Valentine, who laid out several portions of what is now the Great Eastern Railway. Testing ceased on November 25, 1843, and soon after a model of the same kind of line was set up at the Hall of Commerce, in Threadneedle Street, City. Here an engine and train, on a scale of 1½ inches to the foot, went easily around a curve of 9 feet radius, and is said to have run 50,000 miles very satisfactorily.

The idea of wooden rails seems to have originated with a Mr. William Prosser, who, at the period named,



WOODEN RAILWAY NEAR BATH, 1741.

was secretary to the Metropolitan Wood Paving Company. It will be obvious, however, that flanged wheels would not answer, as there would be severe abrasion of the inner edges of the rails. To overcome this difficulty, Mr. Prosser patented a system of inclined guide wheels, or safety wheels, running on bevel axles and placed at an angle of 45 degrees. They worked on the inner side of the rails, and were cast with an angular double flange, corresponding with the edge of the rail, and presenting a surface at the top and side of it of about 3 inches. The rails were 6 inches square, and secured to transverse sleepers, the ordinary carrying-wheels being broad and flangeless and making their path on the top of the rails as they would, being prevented by the deeply-grooved guide-wheels from getting off the line. Driving-wheels, of course, had to have plain tires like the carrying-wheels, but the extra width which could be given to the tread was an advantage, as spreading the weight over a larger surface and reducing the strain on the wood. In point of safety, the guide-wheels were also a good feature in the system, as if any of the plain wheels or their axles failed, the rectangular groove would bear upon the rails and carry the vehicle safely enough. They acted, in fact, like rotary flanges, not touching the rails till the swerving of the engine or carriage brought them into action. There was a pair of guide-wheels at each end of every vehicle used on the railway, two pairs of plain broad-tired wheels bearing the load between them. During the summer of 1845 a further series of experiments, designed to test the merits of the invention on a more practical scale, were tried upon Wim-



WOODEN RAILS AND ENGINE FITTED WITH DIAGONAL GUIDE WHEELS, 1845.

bledon Common. A line, resembling a racket-bat in shape, was laid down a little to the east of the windmill, the broad end lying on Putney Heath and the other extending in a southerly direction. The trains ran along the straight part, or handle of the bat, then round the semi-circular portion back to the starting-point. All sorts of inclines were again laid down—1 in 50, 1 in 80, 1 in 200—while the curved line had a radius of ¼ of a mile and a gradient of 1 in 80 at one place. Similar rails to those used at Vauxhall were employed, but the engine was much larger and heavier, and drew a tender and five small coaches of two tons each. Sometimes the train was run around the circle for a long time without stopping, numbers of people traveling on it without accident, including many members of Parliament and scientific men. The total length of the line was about 2 miles, from starting at the beginning of the straight part to getting back there. The speed was usually 25 to 30 miles an hour, and could have been greater with safety, had the carrying-wheels of the engine and tender run loose upon their axles, as it was intended, under Prosser's system, they should. In June the engine and train were running 6 hours a day, an omnibus going from the Bank of England at 12 o'clock and 4:30 P. M. specially to take down visitors. A portion of the line was laid with iron rails, to show that the guide-wheels would do equally well on them. A company, termed Prosser's Patent Guide-Wheel Company, seems to have laid down the line, but although it was so near London, and the "railway mania" was at its very height at the time, it does not seem to have attracted much notice. Major-General Pasley, Board of Trade Inspector of Railways, reported favorably of the system, having had undisturbed possession of the Wimbledon line for three days, during which he tested it in every possible way. The first day's running was inauspicious, the engine and tender being thrown off the line at the junction by a man who had been discharged earlier in the day for being intoxicated. About £100 worth of damage was done, and the opening delayed some days. The locomotive was "an old, worn-out, tilt-hammer engine," with cylinders 12 x 18—no doubt a four-wheeler originally. Another account calls it "an old lathe engine of Rennie's, without springs, weighing 11 tons empty, and 13 tons full," but it would have taken 1½ years to build a suitable one, builders being so busy. The line was fearfully rough, and proved very trying to the travelers, but no doubt it showed all the better what the system could do under adverse circumstances. The plant was advertised for sale in January, 1846.

Although it was never expected to supersede iron rails on main-line railways, it was thought that Prosser's system might do for branch lines and feeders of small traffic. The Guildford branch of the London and South-Western Railway was intended, as an independent line, to be so laid, though the big company absorbed it before that was done. In Ireland, the Waterford and Kilkenny Company was going to lay it, but changed its mind, Mr. Prosser taking in the one case £20,000, in the other £32,000, for canceling his agreements.

About 1857 an attempt was made to revive Prosser's idea for the benefit of Australia, hard woods being abundant, and iron rails, of course, very costly. For pioneer lines it might have been worth trying as a temporary expedient, but it does not appear that it ever was. That wooden railways are even now capable, under peculiar circumstances, of doing useful service, is proved by the example of one opened at Quebec only last year. W. B. Paley.

London, S. W., March, 1901.

AMERICAN ENGINEERING PROGRESS.*

III. THE INFLUENCE OF COMBINATION.

The creation of a large number of gigantic "trusts," or "combines" (the word "trust" is used in its popular sense in this article) which the United States have seen formed, especially within the last two years, can hardly fail to have considerable influence on the trade of that country, and may affect our own industry to an important extent. When I was last in America there was in progress a government inquiry on this subject which appeared to be on very much the same lines as one of our own parliamentary committees. Business men and the newspapers were discussing the problem at great length, different opinions as to the good or evil of the system being set forth much in accordance with the political leanings of the disputants. The case for these combinations was very ably put to me in a conversation with the organizer of one of the most important of them. Perhaps I cannot do better than to summarize the points in their favor by quoting the views he put forth. The combination of works which my friend represented included the majority of the steel tube factories of the country. The arguments were, generally, as follows: In order to work to the best advantage and produce most economically, it is necessary to manufacture on a big scale and to specialize. For instance, when the tube industry was carried on by a large number of independent works, each establishment made several different kinds of tubes, and each had to support a plant which was idle a large part of the year. On the other hand, when these separate factories were brought under one management, the orders were distributed so that each factory would be kept constantly employed on the class of work for which it was most fitted, and waste of time and labor was thus prevented. The managers and foremen of each works would be able to devote their attention to the perfecting of one type of machinery, with the result that one thing would be done well, instead of half a dozen things indifferently. Another advantage claimed was that if in any one of the factories a man of exceptional talent were found, the results of his labors would be given to the whole of the combination. As an actual instance, one of the tube works that ultimately came within the combination had in its employ a metallurgist of exceptional ability, who had made great improvements in the description of steel used for tube making. As the combination comprised most of the principal tube works in the country, the demand for steel was sufficient to keep a large steel-making plant fully employed. American tubes, it was therefore claimed, were of a superior quality. Further, the management having command of the supply, there was no fear that the work would be kept waiting for raw material, a most important consideration. The reductions in salaries, office expenses, cost of travelers, and of other general charges, were also put forward by my informant as sources of saving.

No doubt these are powerful and legitimate arguments in favor of combination, and it was hoped that by their aid the foreign market for steel tubes would be ultimately commanded by the United States—or, in other words, by the big "combine" represented by my informant. There is, however, another side to the question; and it is possible that, from a public standpoint, these undoubted benefits of combination may be more than counterbalanced by the fact that combination destroys competition. It is in vain that the supporters of the trust system point to instances of a reduction in price following the formation of one of

* London Times.

these monopolies; that, in the nature of things, is likely to be but a partial and transient result, or at any rate a result not commensurate with the cause. Manufacturing establishments are run with the view to making the biggest profits that circumstances will allow; and those who think that patriotism or philanthropy will induce proprietors of works to rest content with smaller incomes than they might otherwise obtain must have a stronger faith in the self-sacrificing character of investors than, it seems to me, experience warrants. It is difficult to believe that trusts and combines, which destroy competition, will not ultimately lead to an undue inflation of prices and consequent reduction of output, resulting in the degradation of the trade of a country.

Still, due weight must be given to the advantages of manufacturing on a big scale. Probably the ideal condition would be reached when there were sufficient independent and competing establishments to keep prices moderate and output brisk, without splitting the industry up into such small units as to make production unduly expensive. We need neither a monopolizing trust nor a garret industry. To secure the full advantages, however, of the mammoth factory, it is necessary to give the heads of departments a substantial personal interest in their work by distributing among them a share of the profits. Payment by fixed salary alone, however high, generally means stagnation. That is human nature, of which some one has said there is a great deal in a man.

Allowing the views here put forward to be sound, it will be seen that those who fear that American competition is going to gobble up English trade, or who look on the advance of the United States as the loss of Great Britain, have something ultimately to expect from the spread of American trusts and combines. We are not likely to see the same system established to any great extent or in very permanent fashion in England, because it is protection that makes it possible. During a greater part of last year manufactured steel was dearer in the United States than in England; and it is evident that, had there not been a prohibitive duty, we should have been shipping plates and angles to America, or the threat that we should do so would have brought the price down. Such a circumstance could hardly have been otherwise than advantageous to America at large, however much it might have reduced the millions of the steel makers. A special industry of our own which is said to be threatened by America is that of shipbuilding. The director of one of the largest shipyards in America lately said that England need not be at all uneasy on this score, because the steel makers have an understanding that their prices shall never fall to a low standard in America, even if they have to sell cheaply in the foreign markets. The fact has already been alluded to in a former article. British shipbuilders may have, therefore, not only the advantage of unrestricted competition among native steel makers, but also the benefit of the cheap surplus steel of America, while American shipbuilders may have at the same time to pay an enhanced price for American steel. The gentleman above mentioned told me of an instance in which an engine builder bought an American-made forging from England. It had come back by way of Canada, and he was able to purchase it at a less price than it would have cost him if he had bought it direct from the Pittsburg works where it was made.

It remains to be seen whether the American steel makers will be able to keep up the policy—the "surplus product policy," as it is called—of making the home market supply the profit and unloading their surplus at cost abroad. If there is a reversal of the protectionist policy, they will fail in their endeavor; and it may be said that all the claim American steel makers may once have had for protection of an infant industry has long since disappeared.

That the United States' principle of producing everything within their own borders must act as a bar to the shipping industry, because there will be an absence of return freight, is a plea for freedom of trade put forward both by Englishmen desirous of reassuring our home shipping industry and also by the few free-traders of America. Evidently cargo can be carried much more cheaply in a ship that is filled both on her out and home voyage; but it is worth remembering that the principle applies to British ships as well as to those of America. Thus, if there is a cargo of American machine tools or agricultural implements to be brought to England and nothing to go back to America, there is one idle voyage, whether the ship be English or American. It would seem that where protection is most likely to act detrimentally upon the American shipbuilding and shipowning industry is in the opportunity it gives to steel makers of arriving at an understanding to keep prices of material artificially high by means of combines, trusts, rings, or other methods of restricting competition. It would be foolish, however, for British manufacturers to allow the possible perils to American industry from American combinations to lull them into a false security. At present nearly all the big combinations are young and full of vitality; if they grow decrepit, they will be supplanted.

The absence of a leisured class and the native shrewdness of the American no doubt account for the comparative fewness of large joint-stock companies or "industrials," with shares of small value largely distributed among the public, such as are often promoted in Great Britain. The capitalist, large or small, in the United States generally finds employment for his money in his own field of enterprise. In vain for him are spread the blandishments of the "front page." The promoter is a different man altogether on the other side of the Atlantic; he appeals to another side of human nature. There is not the same numerous class of military and naval officers, parsons, country gentlemen, retired medical men, and, above all, their female relations, nor generally the multitude of credulous people with small incomes and less knowledge of business affairs, to be tempted with big promises based on the most slender foundations of fact. In America men make money rather than inherit it.

These things are not so true of the present as they were of the not distant past; and it would seem that the trust system, with its meretricious promises of vast profits, is likely to bring about in America a state of affairs analogous to that which prevails with us. It should also be said that these statements apply more to the newly settled districts than to the older cities; but in speaking of the United States we must remember that there are towns besides New York, Philadelphia, and Boston, and even beyond Chicago.

An aggregation of small investors—or industrial punters, as they might more appropriately be called—who have swallowed the bait of impossible returns, do not make a good proprietary for a trading concern. Immediate returns alone mean to them successful management; they have not knowledge to give them foresight, or restraint to make them provident. The management has to trim its sails to woo the fickle breeze of popular approbation, won only by a big dividend. With probably an over-capitalized business this is difficult enough to provide; and thus the great evil is brought about of small provision for depreciation of plant, a depreciation owing less to machinery wearing out than to its becoming obsolete.

Some time ago two English engineers inspected a new engine works in Germany. At the completion of their round, one, who was the managing director of a large works, said:

"How can we expect to compete with these people? They go everywhere and copy everything that is newest and best. Naturally they can turn out work more cheaply than we can. To be equal with them, we should have to throw out half our machinery and appliances."

The reply to this seemed pretty obvious to the other. "If it pays these foreigners," he said, "who are comparatively unknown in the business, to lay out money on such advanced appliances, surely it ought to pay you better still?"

"That's very true, but we have not the money," the first speaker replied.

"Then you have not written off enough to depreciation account, which is bad business."

"That again is true; but if you had to satisfy several hundred shareholders every year you would find out how impossible that is."

"Why not raise fresh capital?"

"Because the average investor is so constituted that he hates to be asked for more money, and objects still more to others supplying it. Such a proceeding would be highly unpopular with the shareholders. And," he added, "in this particular instance the shareholders would be quite right. If we had all these things in England, we could not get the men to use them. It would be just throwing money away."

I quote this, not that I agree with the latter statement, but because it very well illustrates the difficulties of the average manager of a big limited liability company with the labor problem on one hand and the dividend difficulty on the other.

The want of success in big public companies, however, is not always due to the workmen and the shareholders. One can call to mind many large works, prosperous enough when owned privately, which have hardly declared a dividend since floated as a public company. The change of proprietorship from one or two active partners to some hundreds of shareholders can hardly fail to work disadvantageously. If the chairman and managing director are exceptional men, the change may not make much difference; but in dealing with the trade of the country at large we have to consider average capacity. Now, unfortunately, the average man—whether British, American, German, or French—is so constituted that if he gets into a position with a comfortable salary assured he ceases, after a time, to put forward supreme effort—I am trying to put the matter with least offense—and settles down to doing no more than will suffice to quiet his conscience and keep the business afloat to bring in his salary. In other words, it is seldom that one can compensate for the "master's eye" and the master's brain. That is what enables the smaller privately-owned factories to stand up against the otherwise overwhelming advantages of buying and selling on a very big scale. Of course, there are exceptions, men with a sense of devotion and a passion for work out of the common; and there are also cases of limited liability companies in which the proprietary is so largely in the hands of the directorate that the personal incentive is sufficiently strong. But the difference between a manager who will receive, in any case, a fixed salary of £1,000, £2,000, or £3,000 a year, and perhaps, in addition, a comparatively small percentage on extra profits, and one who, as owner, gets all or nothing, must be fairly evident. In Great Britain we have too many manufacturing establishments, heavily over-capitalized, from which is it hopeless to expect very much more than that they will pay salaries and meet other expenses. England has too long been the Tom Tidler's ground of the company promoter.

As regards the formation of trusts and combines on a gigantic scale, the United States seem to be surpassing us in this questionable field of enterprise; and though, for a time, by the aid of protection the American "surplus product" may be the cause of injury to some of our industries, it is difficult to see that the final result will be otherwise than detrimental to the manufacturing industry of the United States.

THE SPEED OF EXPRESS TRAINS IN EUROPE.

In an article in the Archiv für Eisenbahnwesen, Mr. W. Schulze makes a study of fast railroad trains in Europe which is exceptionally complete and ought to be authoritative, as it is based on the time-tables of the railroads of the several countries. On few subjects do more erroneous opinions prevail. Any extraordinary performance, though by a single train and for a moderate distance, is heralded around the world; and the country in which it occurred is credited with having the fastest service in the world, when in fact 99-100ths of its trains may be comparatively slow.

Until very recently, both the highest speeds and the average speeds of trains were so much faster in England than in any Continental country that comparisons were hardly thought of. Of late years, however, speed has been greatly increased on many German trains and still more so on French expresses, and the impression seems to be general that England has fallen behind, as indeed it has in the sense that it no longer has the train with the greatest speed.

Mr. Schulze has aimed to show the speed of the fastest trains on all considerable lines of all limited trains (trains de luxe), and of all trains which run 90 kilometers or more without stopping, in all European countries. His 16 pages of tables give the termini, distance, starting and arriving time, time of trip between termini, number and duration of stops, actual running time and speed per hour of trains over 46 routes in Germany, 30 in France, 13 in Great Britain, 21 in Austria-Hungary, 11 in Russia, 7 in Switzerland, 13 in Italy, 5 in Spain, 4 in Sweden, 4 in Roumania, 3 in Portugal, 3 in Denmark, 3 in Norway, 5 in Belgium, 6 in Holland, and 1 each in Bulgaria, Greece, Servia and Turkey. In many cases the data are given for several trains over the same route.

From these tables it appears that the fastest train in each of the several countries has the following speed in miles per hour:

Fastest Trains in Europe.

France	58.1
Great Britain	54.5
Germany	51.1
Belgium	49.4
Holland	46.8
Austria-Hungary	45.5
Italy	41.7
Russia	38.3
Denmark	37.0
Roumania	36.1
Sweden	35.5
Switzerland	34.6
Servia	31.9
Spain	30.6
Norway	28.1
Portugal	27.1
Turkey	26.3
Bulgaria	21.9
Greece	20.9

The longest runs without stopping are in France; Dax-Bordeaux, 92 miles, at 58.1 miles per hour (lessened since the accident near Dax); Angoulême-Bordeaux, 87 miles, 57.3 miles per hour (the same train as above); Paris-St. Quentin, 96 miles, 56.3 miles an hour; Paris-Arrás, 120 miles, 55 miles an hour; Paris-Amiens, 81 miles, 54.2 miles an hour; Dijon-Laroche, 100 miles, 52 miles an hour. At speeds a little less than 50 miles an hour runs of 143 miles and 148 miles are made without stopping.

In England the run at fastest speed (54.5 miles per hour) is between Grantham and York, 83 miles; but runs of 120 miles (Bristol-London), 127 miles (London-Nottingham), 141 miles (Crewe-Carlisle), and 158 miles (London-Crewe) are made at speeds exceeding 50 miles an hour.

In Germany the highest speed (51.1 miles per hour) is made in a run of 99 miles between Wittenberg and Hamburg, and the longest run without a stop is 124 miles, between Munich and Nuremberg at 41 miles an hour.

The long runs without stop of other countries are less important: 78 miles in Belgium, 85 in Holland, 85 in Austria, 65 in Russia, 90 in Italy and 57 in Switzerland are the longest.

The fastest train in Europe at the time these data were compiled was the French part of the limited Paris-Madrid train known as the "Southern express." It ran the 363 miles from Paris to Bordeaux at the average speed of 56.7 miles per hour. Since the accident to this train near Dax the speed over part of the French route has been reduced, but perhaps not between Paris and Bordeaux. Passengers on this train pay 50 per cent more than the regular first-class express fares. This is much the fastest "train de luxe" of the International Sleeping Car Company. No other reaches quite 50 miles per hour.

The new very fast expresses in France as a rule carry only first-class passengers, which in a country where nine-tenths of the travel is in the lower classes is a serious limitation; but this practice is much older than the high speeds, and has been followed with trains running less than 35 miles an hour. On the fastest trains of nearly all other European countries second-class passengers are taken, and third class on not a few. For instance, between London and Newcastle, 272 miles, there are four expresses running more than 50 miles an hour, which carry all classes of passengers, besides five other fast trains, at 41 to 48 miles an hour, also carrying the three classes. From Berlin to Hamburg, 178 miles, the fastest train, 50 miles an hour, carries three classes; two others with very nearly the same speed, two classes; and four other trains, 36 to 45½ miles per hour, three classes. Now from Paris to Marseilles the two fast trains (48 and 49 miles per hour) carry only first class passengers; the two expresses which carry the second as well as the first class run 38½ and 41 miles an hour; while the four trains open to all classes run from 33 to 35½ miles an hour. The Paris-Bordeaux route has, besides the Southern express, two expresses with first class cars only, one making the trip in 7 hours 5 minutes, the other in 8 hours 34 minutes. The second and third class passengers by four other trains must spend from 9 hours 50 minutes to 10 hours 23 minutes on the road—40 to 42 miles an hour. The Paris-Calais fast expresses carry two classes; and one train carrying third class runs 44½ miles an hour (the fastest express 53). If the average speed is taken of what are called express trains on any one route, the English road is far in advance of any French line (48 miles average between London and Newcastle, 43 miles Paris-Bordeaux, 39½ Paris-Marseilles, 43 Paris-Calais, 44 1-3 Berlin-Hamburg, 41 Berlin-Cologne).

The speed of trains in the different countries seems to have been chiefly developed according to their several necessities, though customs once established have doubtless often been followed long after the circumstances had changed. Germany in the early days of its railroads can hardly be said to have had any great trade centers; but places of considerable importance were not far apart. To run a train 200 miles without stopping at every town of 10,000 inhabitants would have been thought an outrage, and the through travel was seldom large enough to justify long runs without stops, which alone makes very high speed practicable. But things have changed, and between such places as Berlin, Hamburg, Cologne, Frankfort, etc.,

there is a very large movement of passengers, and the whole growth of travel has been such as to warrant special fast trains for the large places while fully accommodating the travel of the intermediate stations by other trains. England from the first had great cities with a large through travel. France lies across several great travel routes, which it has been slow to accommodate properly; but lately has been making up for lost time. In this country we have had to begin at the bottom and have developed the greatest variety of circumstances, with one till lately peculiar to ourselves—tremendously long routes. And while we have some of the fastest trains of the world, the great majority run at so moderate a speed that the average, if ascertained (which perhaps might be easily done in a year's work over The Official Guide) would probably astonish the average man.—The Railroad Gazette.

BOYER LONG-STROKE PNEUMATIC HAMMER.

THE New Taite & Howard Pneumatic Tool Company, Limited, of 63 Queen Victoria Street, London, E. C., have introduced a tool which contains some very interesting features, from a mechanical point of view, as well as from an economical. This is the Boyer long-stroke hammer, illustration of which we give below in Figs. 1 to 5.

This hammer is a powerful tool. The smaller hammer, though well suited for chipping, caulking, etc., was found to be not quite powerful enough for heavy riveting; the result being that the long-stroke hammer we are about to describe was designed. To outward appearance it resembles the chipping hammer, though considerably longer, but the internal details of construction are somewhat different. Fig. 5 is a perspective view of the hammer, Figs. 1, 2, and 3 longitudinal sections through the axis of the tool (the latter view being taken at right angles to the two former), and Fig. 4 is a detail of the clip, *G*, to a larger scale. The reference letters to each part are the same in each view.

On reference to the figures, it will be seen that the tool consists of a cylindrical body, *A*, which has secured to its rear end the grasping handle, *B*, through which there is an inlet passage, *C*, for the motive fluid, the entrance of which is controlled by a valve which is operated by the thumb lever, *D*, Fig. 1. Upon the front end of *A* is screwed a cap or nose-piece, *E*, having a central bore which receives the shank of the riveting tool, *F*. This riveting tool is prevented from pulling out by the spring clip, *G*.

Within the cylindrical bore of *A* is a long bush or sleeve, *H*, which forms the chamber within which the piston, *I*, works. This sleeve is held in place by pins, which are not shown, driven through it and the casing, *A*, and by a flat ring, *J*, clamped between the front end of *A* and an internal annular shoulder on the cap, *E*.

Beyond the rear end of the sleeve, *H*, the cylinder, *A*, is bored out to form the chamber, *L*, which has within it at its rear end a flanged bushing, *M*, the internal bore, M^1, of which forms the extreme end of the piston-chamber, and receives the piston, *I*, at the rearward end of its stroke. The flanged rear portion of the bushing, *M*, has a series of holes bored through it which communicate at their forward ends with the chamber, *L*, and at their rear ends with a circumferential groove, *O*, in the handle or cylinder head, *P*. This groove communicates with the inlet passage, *C*, in the handle, *B*, so that when the thumb-lever, *D*, is depressed the air will be admitted to the chamber, *L*.

On the outside of the central tubular portion, M^1, of the bushing, *M*, is a sleeve, *Q*, provided with an outwardly projecting flange at its forward end, which bears against the front end of a coiled spring, *R*. This spring surrounds the sleeve, and at its rear end is seated in a circumferential recess, *S*, in the bush, *M*. The sleeve, *Q*, forms a second throttle valve independent of that within the handle, *B*, and controls the admission of the motive fluid to the piston, as will be described hereafter. The spring, *R*, forces the sleeve, *Q*, forward, and holds it in the position shown in Fig. 3, in which position its flanged forward end seats within a circumferential groove, *U*, formed between the end of the sleeve, *H*, and the cylindrical casing, *A*, while the body of the sleeve covers a groove or annular space, *T*, between the rear end of the bushing, *H*, and the front end of the portion, M^1, of the bushing, *M*, and so cuts off the communication between the chamber, *L*, and the interior of the piston chamber through the groove, *T*. For the present the sleeve, *Q*, may be assumed to be forced rearward to the position shown in Figs. 1 and 2, and uncovering the groove, *T*.

Communication between the air supply in the chamber, *L*, and the rear end of the piston through the groove, *T*, is further controlled by a valve, *V*, placed in an annular chamber in the rear end of the bushing, *H*. When moved to the rearward or left-hand position, Fig. 2, the valve, *V*, covers the groove, *T*, and cuts off communication between the air supply and the rear end of the piston, and when moved forward or toward the right hand, Fig. 1, it uncovers the groove, *T*, and allows the air to pass from the chamber, *L*, to the rear of the piston, assuming the valve, *Q*, to be in the position shown in Figs. 1 and 2. The front end of the valve, *V*, when in the position shown in Fig. 1 covers an annular groove, *W*, and so cuts off communication between the piston chamber and the exhaust openings, *X*, for the rear end of the piston chamber. When the valve, *V*, is moved to the position shown in Fig. 2, it uncovers the groove, *W*, and opens communication with the exhaust.

At the forward end of the piston cylinder is a second similar valve, V^1, the forward end of which controls the inlet, T^1, through which the air is admitted to the front end of the piston chamber, and which also controls an exhaust groove, W^1, communicating with the exhaust outlets, X^1. The air is conveyed from the source of supply to the groove, T^1, through two passages, *Y Y*, which are shown dotted in Figs. 1 and 2, and full in Fig. 3, and which extend along the cylinder, *A*, and communicate at their rear ends with the circumferential groove, *U*. When the valve, *Q*, is pressed back to the position shown in Figs. 1 and 2, the live air will pass from the chamber, *L*, through the passages, *Y Y*, to the groove, T^1, and from there to the front end of the piston chamber, when the position of the valve, V^1, permits.

The two valves, *V* and V^1, are connected by two small rods or wires, $A^1 A^1$, which extend along the cylinder wall from one to the other, so that when the valve, V^1, moves rearward its motion is communicated to the valve, *V*, moving it rearward also. Similarly when the valve, *V*, is moved forward its motion is communicated through the rods to the valve, V^1. The rods are not attached at the ends to the valves, but could be if desired.

The valves, *V* and V^1, are a good fit on the piston, *I*, so that when the latter enters the valve, V^1, for instance, at the forward end of the stroke, it cuts off the portion of the piston cylinder in front of the said valve from communication with the groove, W^1, and the exhaust ports, X^1. The movement of the piston forward after entering the valve compresses the air in front, and this air acting on the forward end of the valve, V^1, forces the valve rearward, as in Fig. 2, and thereby closes the exhaust groove, W^1, and uncovers the live-air groove, T^1. This rearward motion of the valve, V^1, to the position shown in Fig. 2 will, by means of the wires, $A^1 A^1$, move the valve, *V*, at the rear end of the piston chamber, and thereby cut off the inlet for the air to the rear end of the piston, at the same time opening the rear end of the piston chamber to the exhaust through the groove, *W*, and the exhaust ports, *X*. The piston at the end of its forward stroke is not arrested by the air confined in front of it after it enters the valve, V^1, but continues its motion till it delivers its blow to the riveting tool, *F*, as in Fig. 2. The reason for this will be clear when it is explained that while completing its forward movement the piston passes through a loose bush or sleeve, B^1, which is made to slide backward and forward in a chamber within the cap, *E*. The sleeve, B^1, is provided with several internal grooves parallel with its axis, which permit the air in front of the piston to pass back, and not form a cushion between the piston and the shank of the riveting tool, *F*. The rebound of the piston from the blow will start it back, and its further movement will be effected by the live air which is admitted in front of it, through the groove, T^1, which has been uncovered by the rearward movement of the valve, V^1. At the end of its backward movement the piston passes entirely through the valve, *V*, and enters the bushing, *M*, which it fits, so that the air in the bushing is trapped and compressed, thereby cushioning the piston and starting it forward again. When the rear end of the piston passes forward out of the bushing, *M*, the live air is admitted behind it through the groove, *T*, which has been opened by the forward movement of the valve, *V*, and drives it forward for its next blow.

Abutting against the rear face of the loose sleeve, B^1, are the ends of two rods, D^1, which extend through the passages, *Y Y* (before referred to), and at their rear ends press against the cylindrical valve, *Q*, Fig. 3. The coiled spring, *R*, presses the valve, *Q*, forward, and through the rods, D^1, forces the sleeves, B^1, and the riveting tool, *F*, forward, holding them normally in the position shown in Fig. 3, in which position the valve, *Q*, covers both the groove, *T*, and the rear ends of the passages, *Y Y*, and cuts off the live air from both ends of the piston chamber, even if the throttle valve in the handle of the tool be open. When, however, the rivet set, *F*, is applied to the end of the rivet, and the whole tool is forced forward, the shank of the rivet set will slide back, the sleeve, B^1, and the rods, D^1, being forced to the rear, will cause the valve, *Q*, to uncover the groove, *T*, and the passages, *Y Y*, and so admit the live air to the opposite ends of the piston cylinder.

In this way the motive fluid is automatically admitted to the tool by the act of pressing the latter up to its work. This provision for preventing the opera-

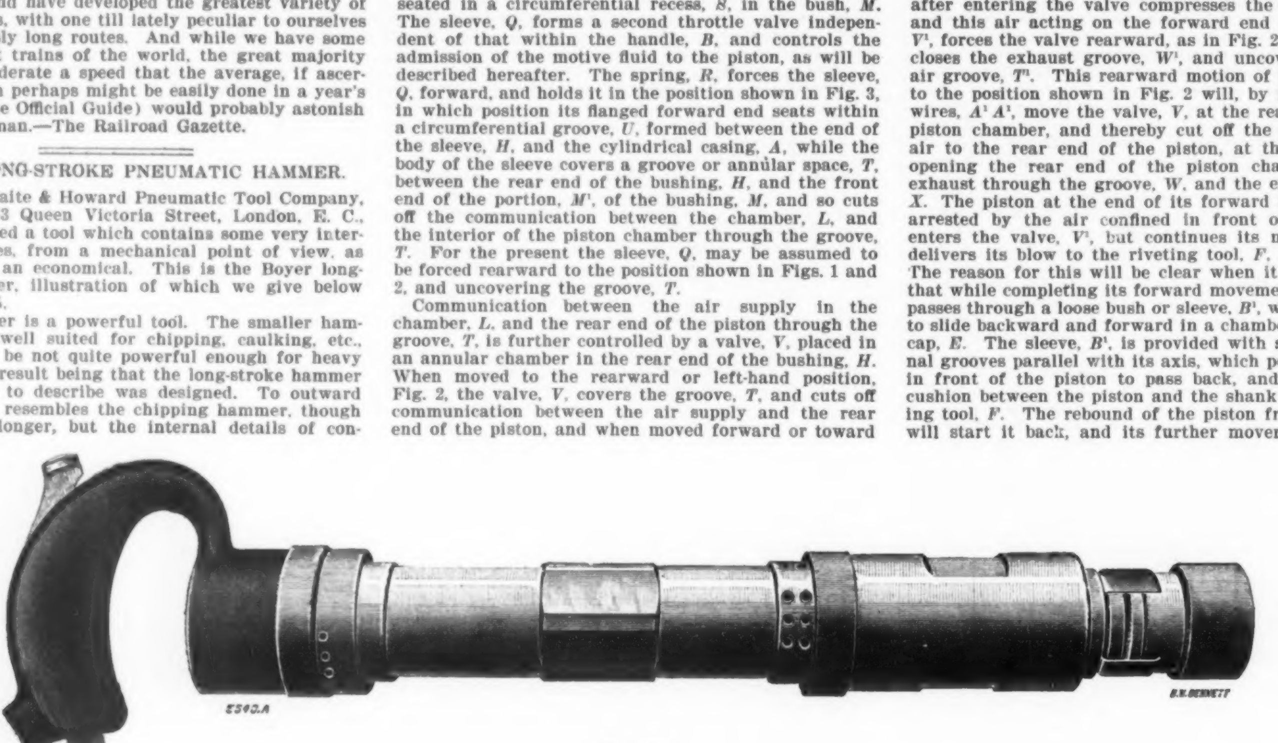
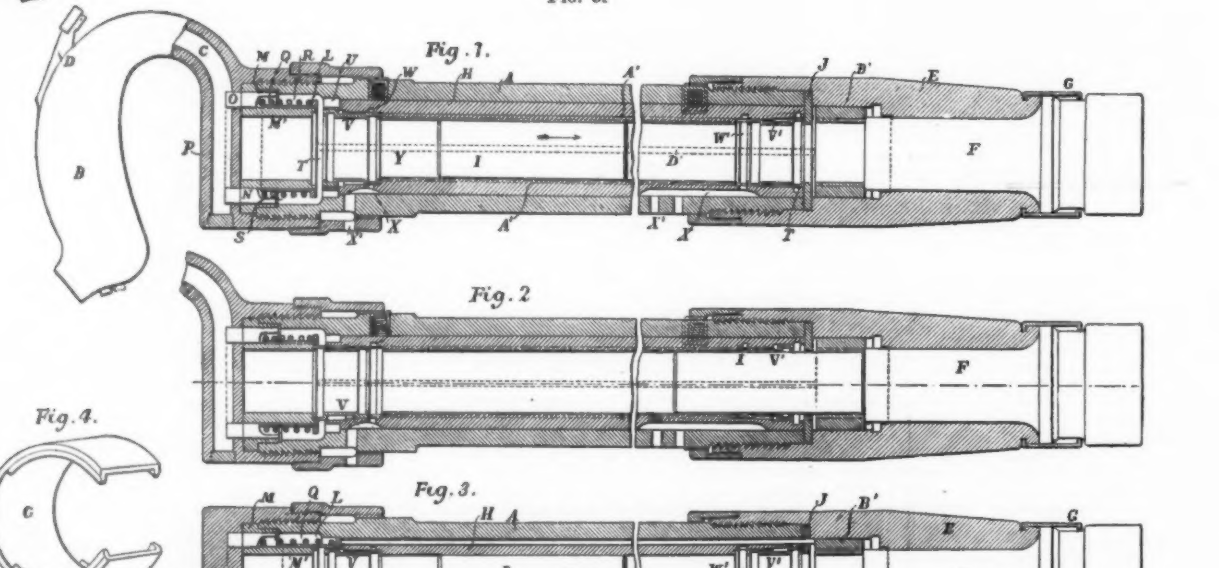


FIG. 5.



THE BOYER LONG-STROKE PNEUMATIC HAMMER.

tion of the tool, except when pressed up to its work, is important, since otherwise the tool might be run without anything to resist its powerful blows, and there would be great danger that its entire front would be knocked off.

For the purpose of connecting the rivet set to the body of the tool, while allowing it to be easily detached when required, the spring-clip, *G*, shown on Fig. 5, is provided. It is cut away at one side, and provided at its opposite ends with internal flanges which engage with annular shoulders on the front end of the cap, *E*, and on the rivet set, *F*. The clip can easily be sprung off when required.

It will be seen by the above description that the length of the stroke is not in any way limited by the length of the piston, for by lengthening the cylinder any increase can be given within reasonable limits, or the length of the piston can be decreased, thereby giving a longer stroke with a lighter piston.

The workmanship of all the parts of this tool is excellent, and reflects great credit on the makers. We have seen it in operation while closing up 1-inch diameter rivets, and were struck with the expeditious way in which it worked. We have examined specimens of riveting where a row of 1-inch diameter rivets was put through several thicknesses of plate, alternately with rivets of the same diameter closed by hydraulic pressure. The plates were afterward cut through along the center line of the rivets, and we could see no difference between the work performed by the hydraulic rivet and the pneumatic, so far as its soundness was concerned. The pressure of air used was about 100 pounds per square inch.

We understand from the New Taite & Howard Pneumatic Tool Company, Limited, that owing to the great and increasing demand for their tools on this side of the Atlantic, and the difficulty they have in procuring them from America within a reasonable time, they are now making arrangements for the manufacture of them in this country. We understand that there are already over 1,500 of these pneumatic tools at work in the United Kingdom. For ship work they seem to be particularly well adapted, and when used in conjunction with the pneumatic holder-on, when three men and a heating boy are able to drive from 800 to 1,000 ¾-inch rivets per day of 10 hours.

The pneumatic holder-on is usually fixed to a frame which may either take the form of a horseshoe connecting the hammer with the holder-up, or have any other suitable shape, and it can be so arranged that the admission of air to the holder-up takes place at the same moment that it enters the hammer, so that the latter cannot be started before the holder-up is in operation.

As to the cost of using this machine, it is said that in America, where they have been so largely adopted, the saving is from 1 to 2 cents per rivet over piecework prices for hand riveting, depending upon the location in the ship, and averaging about 1¼ cents. In an ordinary lake steamer of 4,000 tons the saving is from $4,000 to $5,000 over hand work.—Engineering.

A NEW ELLIPTICAL CUTTING MACHINE.

By Prof. C. W. MACCORD.

IN making mats with an elliptical central opening, for mounting pictures, the material is in many cases cut out by hand, the required outline being previously drawn by means of an elliptograph. The accompanying illustrations show the construction and mode of operation of a machine, embodying some novel features, for cutting out the ellipse without having it drawn—just as if a knife were to be substituted for the pencil in the elliptograph.

Fig. 1 is a side elevation, and Fig. 2 is a top view, both being partly in section; and the parts are lettered to correspond in each. The material to be cut is secured centrally on the top of a wooden turn-table *D*, which is fastened by screws to the horizontal wheel *W*; this turns freely on the vertical pin *O* fixed in the bed-plate *E*. The driver of *W* is the wheel *U*, of half the diameter, which is keyed upon the vertical shaft *T*. This shaft has its lower bearing in the bed-plate *E*, and its upper one *t* in a side bracket forming part of the frame *F*; upon its upper end is keyed a bevel wheel *B*, driven by another one *A*, which is keyed upon the horizontal shaft *S*; and *S* has one bearing in a bracket *a*, also forming a part of the frame *F*. At its other end this shaft is slotted for the reception of feather-keys fixed in the bevel wheel *A'*, which can thus slide upon *S*, but turns with it. An extension of *A'* is turned into a journal, whose bearing is in a bracket *a'* which forms part of a carriage *H* fitted to slide upon guides *GG* secured to the frame *F*. The wheel *A'* drives another bevel wheel *B'* keyed upon the vertical shaft *R*, whose bearing is in a side bracket *h* forming part of the carriage *H*. (The vertical center line *cc* in Fig. 1 corresponds to the point marked *C* in Fig. 2, where *R* is shown in section.)

Projecting from the lower end of *R*, and rigidly connected with it, is a horizontal arm *K* upon which slides a socket *L*, which can be clamped at any position upon the arm, and in a vertical projection on the lower side of *L* the knife-holder is fixed. The wheels *A' A* are of equal size, and also *B* is of the same size as *B*; consequently, since *W* is twice as large as *U*, it will be seen that upon operating the crank fixed on *S* the arm *K* carrying the knife or cutter (marked *P* in Fig. 2) will turn in the same direction as *D*, but with twice the angular velocity.

That this will result in the formation of an ellipse, so long as *C* does not coincide with *O*, Fig. 2, but is located at some distance to one side of it, may be demonstrated by the aid of Fig. 3, in which *D* is a disk carrying the concentric annular wheel whose pitch circle is *W*. Roll within this the wheel *U* to which is secured the arm *ABP*, holding *D* fast meantime; then *A* traverses the vertical, and *B* the horizontal, diameter of *W*, while *P* traces on *D* the ellipse shown, whose semi-major axis *OM* is equal to *PA*, the semi-minor axis *ON* being equal to *PB*.

Now, pivot the disk *D* on its center *O*, and let the wheel *U* also turn about *C* as a fixed center, still carrying the arm *ABP*; the relative motions will be the same as before, and consequently the same ellipse will be traced upon the disk.

It is also to be observed that in this case we have *PC* equal to half the sum, and $OC = AC$ equal to half the difference, of the semi-axes. Regard is to be had to these relations in adjusting the machine for cutting out ellipses of any given dimensions, as will be seen by comparing Figs. 3 and 2, in which *P*, *C*, and *O* correspond. The distance *OC* is varied by sliding the carriage *H* upon the guides *GG*, and the distance *PC* by sliding the socket *L* upon the arm *K*.

Now, it is obvious that the arm *K* corresponds precisely to the trammel-bar in the common elliptograph; and it is well known that in drawing ellipses in ink with that instrument there is difficulty in making a good, smooth line if the eccentricity is considerable, owing to the fact that the blades of the pen are set at right angles to the bar, which is normal to the curve only at the vertices. A similar trouble may be experienced, and probably to a more serious extent, in such a cutting machine as we have described, if the knife were not controlled so as to be always tangent to the ellipse. For the sake of simplicity, we have thus far contented ourselves with causing the cutter, regarded as a point, to travel in the correct line. But Fig. 3 also contains the indication of means by which the control, just mentioned as desirable, may be secured. For in rolling contact between circles, the point of tangency is the instantaneous center, which is a point upon the normal of any curve traced, by a point carried by either circle, upon the plane of the other. In this case, since the centers *O* and *C* are fixed, the point of contact *I* is also fixed; and *PI* is always normal to the curve.

This circumstance may be made available by the means shown in Fig. 4, which is a section by a plane through *cc* perpendicular to the axis of *S* in Fig. 1, after turning the arm *K* through an angle of 90 degrees. In order to introduce this new attachment, the shaft *R* is enlarged, and bored through its length to

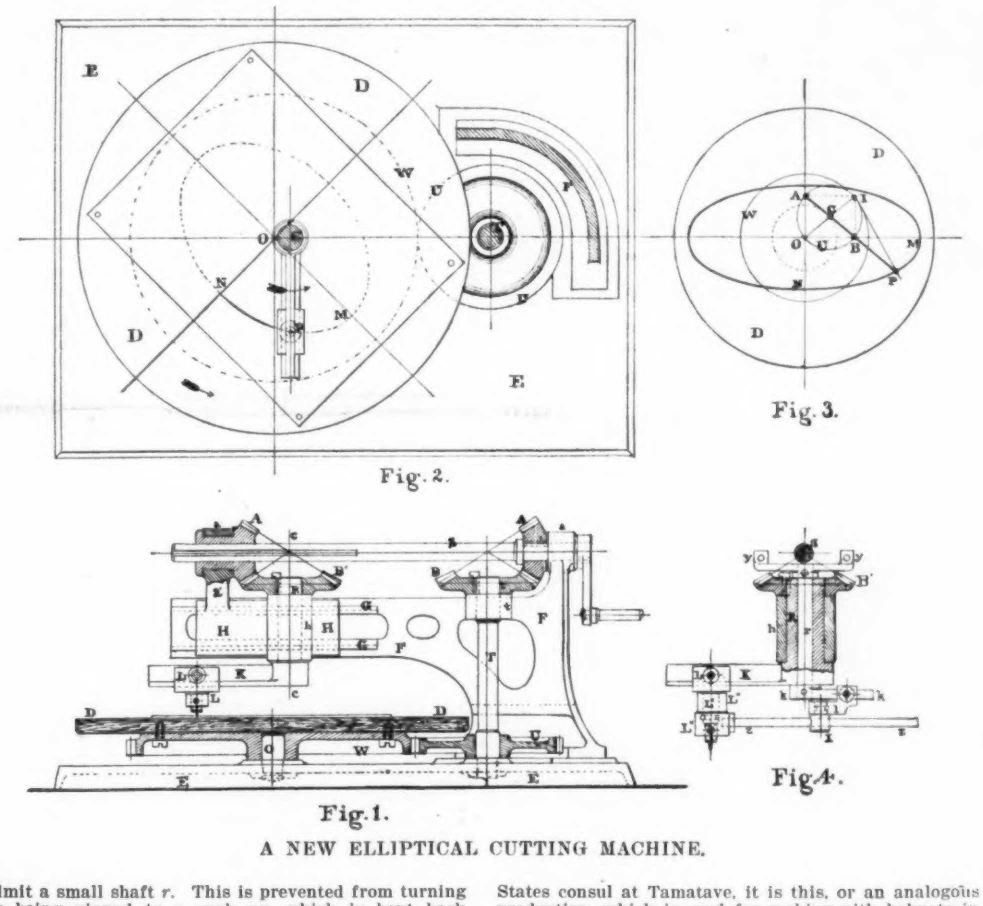


Fig. 2. Fig. 3. Fig. 1. Fig. 4.

A NEW ELLIPTICAL CUTTING MACHINE.

admit a small shaft *r*. This is prevented from turning by being pinned to a curb *yy*, which is bent back around the wheel *A'* (not shown in this view), and bolted to projections formed upon the bracket *a'* of Fig. 1. To the lower end of *r*, which projects below *K*, is keyed or pinned a horizontal arm *k*, upon which a sliding socket *l* may be clamped at any desired point. This socket *l* is vertically drilled, and in the bearing thus formed a neck, projecting upward from the cylindrical head *I*, turns freely.

The socket *L* upon the arm *K* has on the lower side a cylindrical projection *L'*, upon which turns freely another socket *L''*, in the lower side of which the knife-holder is now fixed, instead of being secured directly to *L*; the edge of the knife should coincide, very nearly at least, with the axis of *L'*.

One side of *L''* is drilled for the reception of a horizontal bridle rod *zz*, which slides freely through a corresponding hole drilled through the cylindrical head *I* above mentioned.

The axis of *I*, obviously, corresponds to the point *I*, or instantaneous center, in Fig. 3; and as it is held stationary by its connection with the carriage *H* through the curb *yy*, it is seen that the bridle-rod *zz*, corresponding in position to *IP* in Fig. 3, will be always normal to the ellipse at the position occupied by the knife; and the latter being set at right angles to *zz* instead of to the arm *K*, will be always tangent to the curve.

Such a bridle-rod, connecting the marking point with the instantaneous axis, has been previously adapted by the writer to instruments for drawing ellipses (see SCIENTIFIC AMERICAN SUPPLEMENT, No. 854); but greater or less complications were involved owing to the fact that the elliptographs draw upon fixed planes, and the instantaneous axis is therefore not stationary. In this cutting machine, however, that axis is fixed, and greater facility is found in arranging the rod, which must necessarily improve the action very materially, particularly if the required ellipse is comparatively long and narrow. In regard to the position at which the socket *l* is to be clamped it is seen that in Fig. 3 $CI = CO$; that is to say, that the distance between the axis of *I* and the axis of *R*, in Fig. 4, must be equal to *CO* in Fig. 2; that is, to half the difference between the semi-axes of the required ellipse. The range within which this appliance can be used is obviously limited by the consideration that as the arm *K* goes round the socket *L''* must pass the end of the arm *k*, which, however, gives scope for a considerable variety in both form and size, with the advantage of an action theoretically perfect. We are not aware that the feature of describing the ellipse upon a moving plane has ever been introduced; it certainly seems to present a decided advantage in the action on account of the fact that the motions of the working parts are simply rotations with uniform velocities.

RAFIA FIBER IN MADAGASCAR.

ROFIA, or, as it is generally spelt, "rafia," is the Malagasy name of a palm which furnishes a staple article of commerce called rafia fiber. It is indigenous to Madagascar, and is to be met with everywhere on the coasts, needing neither cultivation nor attention of any kind. It is not a stately palm, but sends its enormous branches from near the ground; in a fine specimen one branch is almost a tree in itself. The rib in each branch is as much as 20 feet long, of a pearly gray color, smooth and shiny, flat on the inner surface, but otherwise round, without any knobs, and so exceedingly hard. At the base it is as large as an ordinary champagne bottle, and tapers to a point at the top. The inside consists of a light pith, which can be split into layers of any thickness. Possibly, says the United States consul at Tamatave, it is this, or an analogous production, which is used for making pith helmets in the East. Naturally these ribs combine great strength with wonderful lightness, and are used for shafts for "filanjanas" or palanquins, ladders, or other purposes, but otherwise have no commercial value. It is the pinnifoliate of these branches which produce the rafia fiber of commerce. One palm branch, or frond, will produce eighty or one hundred long green leaves from two to five feet in length, like the leaves of the sugar cane, but of a dark, lustrous green, and both thicker and stiffer. These, again, contain a round and pliant rib which the natives utilize for making baskets and dredges for catching small fish and shrimps in the rivers after they have stripped off the green part which furnishes the fiber. The under part of this green leaf (which is not exposed to the light, as it remains folded) is of a pale greenish-yellow color, and from that side the inner skin can be peeled off in the same manner as the skin on the outside of a pea pod, except that it peels off straight to the tip without breaking. It is then of the palest green, and after being dried in the sun assumes a light straw color. This is the rafia fiber of commerce. It was originally sought for by the natives for use in articles of clothing. The men bring in the fronds, and women and girls weave it on handlooms, of any coarseness or fineness. Woven just as it is peeled off from the fronds, it forms a kind of sacking used for wrapping goods, while the perfection of the art, as shown by the Hovas only, is to weave a tissue of which the warp is rafia fiber split very fine, and the weft of white silk. This gives an article called silk lamba, which fetches fancy prices in Europe and America. The coast tribes use it for clothing, but of moderate fineness, with dyed stripes or indigo, saffron, black, and a dirty green. It is a cold, comfortless looking material, and refuses to adapt itself to any folds that a sculptor would care to copy. Rafia fiber

is used in Madagascar by nurserymen, gardeners, etc., for tying up vines and flowers, and possibly for grafting. It possesses the advantage of being as soft as silk, and is not affected by moisture or change of temperature so as to risk cutting or wounding the most delicate tendrils, and it does not break or ravel when folded or knotted. These qualities bring it into use all over Europe, and consequently maintain its price. It is virtually inexhaustible in Madagascar, the supply being limited only by the scarcity of labor. For export the fiber is merely collected in large skeins, twisted up or plaited, and then baled like raw cotton. Madagascar exports about 20,000 bales annually.

ELECTRICAL OSCILLATIONS AND ELECTRIC WAVES.*

By Dr. J. A. FLEMING, M.A., F.R.S., Professor of Electrical Engineering in University College, London.

ELECTRIC WAVES.

THERE are one or two questions connected with wave production in general, concerning which a little preliminary discussion may be useful. One physical characteristic of wave motion is that by it energy is conveyed entirely away from the wave-creating body and exists for a time stored up in a surrounding medium. Consider, for instance, the production of a compressional wave in air. If I move my hand or a fan to and fro, the mere production of this motion or change of motion in the material body absorbs energy. When it is so moved in a fluid such as air, the moving solid sets up vortex or rotational motions in the surrounding air similar to those whirls which are seen on moving an oar or the hand through water, and these fluid motions also take up energy to produce them. If a fan is moved slowly through the air, all that happens is that the air in front passes round behind it, and in so doing air vortices are created. Energy is therefore absorbed not only in making changes in motion of the solid, but also is taken up in the surrounding medium in creating this vortex motion or movements in the air which cling to and surround the moving body.

A large part of the resistance to motion which a solid experiences in passing through a fluid is due to this form of energy absorption by the fluid. A perfect fluid or one without any quality of viscosity could not have these motions so set up in it, and hence offers no resistance to the motion through it of a solid.

If the solid oscillates or moves slowly through a fluid, the energy never dissociates itself entirely from the moving solid or from the fluid in its immediate neighborhood. The energy so to speak travels with the vibrating body and exists where it is, or in proximity to it, and when its motion ceases the energy of motion of the fluid is frittered away into heat.

It is quite different, however, if a body is moved or vibrated very rapidly so as to bring into play the inertia quality of the fluid. If, for instance, instead of moving somewhat slowly through the air, the fan or other body such as a tuning-fork is made to vibrate with considerable speed, the inertia and compressibility of the air come into play, with the result that we have a true wave produced. The air has not time to get out of the way of the moving solid, and thus instead of moving round to the back of the vibrating body, it is suddenly compressed and subsequently rarefied and started into oscillations. Each portion of the fluid takes up successively the oscillatory motion or changes of pressure, and energy is conveyed entirely away from the moving body and its neighborhood, and continues to exist in the medium as a wave long after the vibrating body which started has come to rest.

Some at least of the energy imparted to the solid to set it in vibration is taken from it and handed on from point to point through the air.

The characteristic of a true wave is that in each portion of the medium the energy so being conveyed exists alternately as energy of strain or configuration and energy of motion, or in some form equivalent to these types of energy. Moreover, at equal distances, called a *wave length*, similar energy changes are taking place at the same time. The total energy of a true wave of any kind can be shown to be at any moment half potential or configurational, and half kinetic or motional. At each point in the medium cyclical changes of energy take place and the disposition of either kind is periodic in space.

The term *wave motion*, therefore, has reference to this peculiar mode of transferring energy from place to place, and waves can exist in any medium which possesses two essential qualities. The first of these qualities is that some kind of vector or directed change made in it must tend to disappear if left to itself; and not only so, but in being created must call forth an opposition or resistance to its creation. In the second place, in disappearing, the change whatever its nature, must tend to overshoot the mark and be reproduced in the opposite direction; in other words, there must be a persistence or inertia-like quality in connection with the change of deformation.

There may, therefore, be as many different kinds of waves as there are possible modes of deformation in extended media.

Take, for instance, the case of water. If the water has a free surface this is a level surface and tends to remain level. If the water is heaped up in one place and left to itself it begins to regain its level, but it possesses inertia, and in so doing it overshoots the mark and creates a depression in the surface.

From this point, therefore, surface waves spread out, which are changes in level, periodic in time and space. Again, a free water surface possesses what is called *surface tension*. The surface of any liquid offers a resistance to stretching like a sheet of indiarubber. If, therefore, a surface of water is slightly heaped up, the surface is stretched and tends again to become level in virtue of this surface tension. Hence we can have not only what are called *gravitational waves* on the free surface of water, but ripples or *surface tension waves*. These latter may be seen to be formed when a fishing-line or thin rod is moved through water perpendicularly to the surface. Furthermore, water resists compression, and hence we can have produced in it *compressional waves*, not on the surface but in the mass. Such waves are produced in water by an explosion taking place beneath the surface.

In every case, however, the velocity of propagation of the wave is measured by the square root of the ratio of two quantities, one being of the nature of an elasticity, and the other the density or mass per unit of volume. Moreover, in all wave motion the velocity of the wave is measured by the product of the wave length and the number of complete oscillations per second executed by any part of the medium through which the wave motion is traveling.

If V represents the wave velocity, n the frequency, and L the wave length, then we have the relation $V = nL$ as a fundamental equation connecting wave length and frequency.

In the case of solid bodies we can have another kind of wave not capable of being produced in liquids, namely, a *distorsional wave*. The special characteristic of a solid substance is that it resists shearing or being changed in shape. If, for instance, we give a twist to a rod of steel it resists this kind of torsional deformation, but we cannot put a twist of the same kind upon a thread of honey or column of water.

Accordingly we can have a great variety of waves in material media depending upon the fact that their parts possess inertia, and that they resist some kind of relative displacement. Thus, for example, we may have:

Gravitational or surface waves in liquids—due to the resistance of the surface to being made unlevel.

Capillary waves or ripples on the free surface of liquids—due to the resistance of the surface of the free liquid to stretching.

Compressional waves in the mass of a gas, liquid, or solid—due to the resistance to change of bulk or volume elasticity.

Distorsional waves in solid bodies—due to the resistance to shearing, twisting or other changes of a form of any element, in other words to shape elasticity.

These preliminary remarks will pave the way for a consideration of the nature of *electric waves*.

Every dielectric possesses, as we have seen, two properties. It can have a physical state produced in it at any point called the electric displacement, and this corresponds to the production of a deformation or strain in an elastic solid. The medium resists by an elastic reaction the creation of this displacement, and when the electric force creating it is withdrawn the displacement disappears; but as a displacement requires an energy expenditure to produce it, the law of conservation of energy necessitates that the displacement in disappearing shall give rise to energy in some other form. This it does by the creation of magnetic flux in a direction at right angles to itself, and the flux in turn in disappearing gives rise again to a displacement at neighboring points in the same direction as that displacement, the vanishing of which gave rise to the flux. Hence we detect in this operation an analogy with the case of a vibrating solid where mechanical stress gives rise to elastic strain, and strain in disappearing creates velocity or sets matter in motion, and hence reproduces the strain energy in a kinetic form. This again, in virtue of inertia, recreates a new strain in an opposite direction.

We may illustrate this point by a diagram as follows: Consider a row of particles representing the molecules of an elastic solid (see Fig. 1). If one of

FIG. 1.

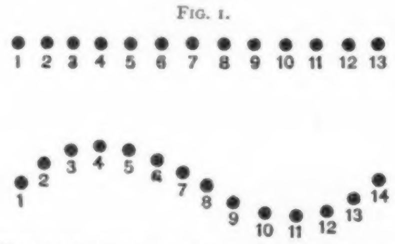


DIAGRAM REPRESENTING THE FORMATION OF A DISTORTIONAL WAVE IN A MATERIAL SOLID BODY.

these is drawn on one side this mechanical displacement is resisted by the intermolecular forces of cohesion. Hence when the molecule is released it begins to return to its mean position. Its inertia, however, carries it on beyond this point, and in so moving it compels adjacent molecules to move with it, but the displacement calls forth a restoring force which finally destroys the displacement again. Hence we have a periodic state in which displacement and therefore energy of strain alternate with motion, and, therefore, kinetic energy. Each molecule in turn passes through the cycle of changes, and hence a wave of mechanical displacement is propagated from point to point. Consider in the next place the mode of production of a wave of electric displacement. Imagine a dielectric cut up for convenience of illustration into tubes which are slightly separated (see Fig. 2). Consider that along one tube we make an electric displacement away from the reader represented by the black circle or big dot in the middle tube.

By Maxwell's principle this displacement *while increasing* or diminishing is in effect an electric current, and creates round it a magnetic flux represented by the arrows. The action of this flux is to call forth a displacement in adjacent tubes of the dielectric and to tend to annul that already created. Hence it is easy to see that the operation of making an electric displacement along any line in a dielectric which is then left to itself must be to propagate out in the surrounding region a wave of electric displacement. Each portion of the medium successively and periodically sustains an electric displacement, and this, while increasing, creates an embracing magnetic flux the operation of which is to annul the displacement which gave rise to it and re-create the displacement at points lying beyond.

The process of alternating electric displacement and resulting magnetic flux repeated cyclically from point to point through the dielectric, constitutes an electric wave, and the velocity of this wave is measured by the value of $1/\sqrt{K\mu}$ for that dielectric. By the velocity of the wave is meant the quotient of wave length by the periodic time.

In considering these matters the question necessarily arises: What is it that constitutes an electric displacement in a dielectric? Maxwell never committed himself to any opinion as to the exact nature of the physical change which he called the electric displacement.

FIG. 2.

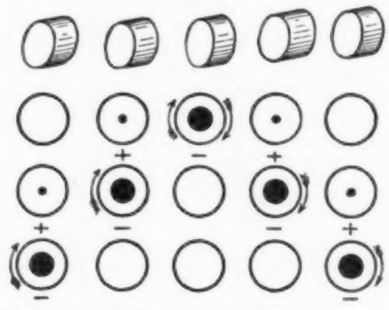


DIAGRAM REPRESENTING THE FORMATION OF A DISPLACEMENT WAVE IN A DIELECTRIC.

Mr. Oliver Heaviside remarks paradoxically that the more general or more vague a physical theory, in one sense the more likely it is to be true, or perhaps we should say the less likely it is to be untrue. This vagueness, however, in this case is felt by some to be unsatisfactory; they want to know whether an electric displacement is an actual motion or a stretch, squeeze, or rotation of an ethereal medium or of the material dielectric. If told that not only do we not know, but that all theories on this matter are most probably wide of the mark, they are apt to feel a degree of disappointment. Yet we are on safer ground when we are content not to demand too much detail at present. Mechanical analogies are helpful as a guide, but we may easily become slaves to an analogy or a catch phrase.

In order that we may create an electric wave we have, however, to cause an electric displacement in a dielectric and to release that constraint very suddenly, just as to produce a compressional wave in air we have to produce or release very rapidly an air compression.

All these ideas had been grasped with some degree of clearness prior to the publication of Hertz's work, but to him we are indebted for a new departure on the subject which brought it at one stroke within the region of experiment. Hertz equipped the secondary terminals of an induction coil with a species of Leyden jar or condenser, which is now known as a Hertz radiator. This consisted of a pair of metallic plates or sometimes balls, having attached to them short rods ending in knobs placed a fraction of a centimeter apart. These knobs were connected to the secondary circuit of the coil. Hence as the secondary electromotive force accumulates, the plates are brought to a difference of potential, and lines of electrostatic displacement stretch out from one part of the oscillator, which we will call the positive side, to corresponding points on the negative side. We have thus a strong electric displacement created along certain lines of electric force.

Corresponding to a critical value of the potential difference, the air insulation between the balls breaks down and it becomes highly conductive. Then the whole radiator becomes one conductor for the moment, and the potential difference begins to equalize itself, that is to say, a current flows from one side to the other, creating in the space around a magnetic flux, the direction of which is everywhere normal to the direction of the electric displacement. The electrostatic energy is, so to speak, melted down into electrokinetic energy. The flux then persists, and re-creates in an opposite direction electric displacement. The condition of the plates just prior to the passage of the air into the conductive condition is represented by the diagram in Fig. 3, where the U-tube drawn over

FIG. 3.

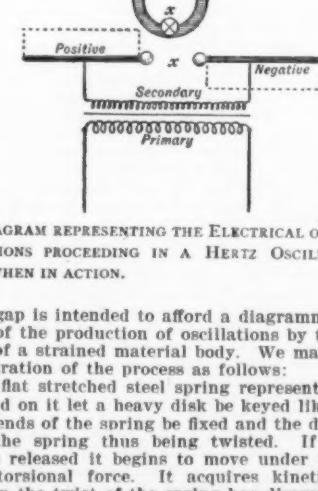


DIAGRAM REPRESENTING THE ELECTRICAL OPERATIONS PROCEEDING IN A HERTZ OSCILLATOR WHEN IN ACTION.

the air gap is intended to afford a diagrammatic illustration of the production of oscillations by the sudden release of a strained material body. We may consider an illustration of the process as follows:

Let a flat stretched steel spring represent the oscillator, and on it let a heavy disk be keyed like a wheel. Let the ends of the spring be fixed and the disk turned round, the spring thus being twisted. If then the wheel is released it begins to move under the action of the torsional force. It acquires kinetic energy, and when the twist of the spring has disappeared, the wheel is possessed of all the energy as rotational

* Lecture Delivered december 17, 1900, before the Society of Arts and published in the Journal of the Society.

energy. This then expends itself in reproducing the twist of the spring in the opposite direction.

If the electric oscillation in the oscillator is started sufficiently suddenly, some of the energy is thrown off in the form of a displacement wave, and as a consequence the oscillations of the radiator, as Bjerknes has shown, are quickly damped out. Accordingly, when the induction coil is kept going we have groups of intermittent oscillations, and therefore trains of electric waves thrown off which travel off or spread out through the dielectric.

Hertz furthermore devised a resonator, a most simple and marvelously effective device for detecting these electric waves at any point in space. This in its simplest form consists merely of a nearly closed ring of wire, the ends being provided with metallic balls placed very close together. The ring may be a rectangle, and it may have a condenser inserted in its circuit, as in the arrangement due to Blondlot. In order that we may secure the sharpness of breakdown in the air insulation which is necessary to obtain the oscillations, three things seem necessary.

First, the spark ball surface must be bright and clean. Secondly, no ultra violet light rays must fall on the balls, especially on the negative terminal; and thirdly, the balls must be at a certain distance apart best determined by experience.

In describing experiments with the Hertz oscillator, we shall call the *axis of the radiator* the direction of the line joining the centers of the spark balls, and the line through the spark perpendicular to this axis will be called the base line. Also the line joining the spark balls of the resonator will be called the spark axis of the resonator. If the resonator is set in front of the oscillator with its center on the base line, then there are three principal positions which the resonator may occupy. First its plane may be parallel to the axis of the radiator and perpendicular to the base line: we shall call this the first position. Secondly, the resonator may have its plane in the plane containing the radiator axis and the base line; we shall call this the second position. Thirdly, the resonator may have its center on the base line and its plane perpendicular to the plane containing the radiator axis and the base line, and placed so that its plane passes through the spark gap; this will be called the third position.

Hertz found that when the resonator is placed in each of these three positions respectively, but not too close to the radiator, and if at the same time the resonator is turned round in its own plane so as to bring the spark axis of the resonator into various positions, different phenomena present themselves.

In the first place, if the resonator is placed in the first position, and with the spark axis of the resonator parallel to that of the radiator, then when the radiator is sparking, small sparks also occur between the spark balls of the resonator; but if the resonator is turned round in its own plane so that the spark axis of the resonator is perpendicular to that of the radiator, then no sparks occur at the resonator.

In the next place, if the resonator is placed in the third position with its plane perpendicular to the axis of the oscillator, then no sparks are seen, whatever the position of the air gap of the resonator.

When the resonator is placed in the second position with its plane parallel to and passing through the axis of the radiator, then sparks are seen in the resonator air gap when that gap is turned toward the oscillator, but they become less and less bright as the resonator is turned round in its own plane, until when the air gap is turned away as far as possible from the oscillator they cease altogether.

In order to explain this spark production in the resonator it is necessary to make reference to an early fact discovered by Hertz.

If the resonator is attached by a wire to one terminal of the induction coil, then when the coil is in action vigorous sparking is seen at the spark balls of the resonator unless the connecting wire is attached to the resonator at a point symmetrical with respect to the spark balls (see Figs. 4 and 5). This is due to the inductance of the resonator circuit.

If the lengths of path measured along the resonator from the point of attachment of the wire to the spark gap are unequal, then owing to their unequal inductance the rise or fall of potential produced by the coil terminal takes effect first at the spark ball attached to the branch of smaller inductance.

One might at first be inclined to suppose that no difference of potential could be created between two balls connected by a short loop of wire, but although this is the case when low frequency oscillations are used, it is not so when the frequency is very high.

The same thing holds good when the resonator is not connected with the induction coil by a wire, but placed at a distance from the oscillator. In this case electric displacement produced by the radiator travels to the resonator through the dielectric. If the spark gap of the resonator is held parallel to the spark gap of the radiator, then the displacement or electric force arriving at the resonator fills the spark gap of the resonator and creates there an alternating displacement, and an alternating potential difference between the balls. When this reaches a certain amplitude the air insulation breaks down and a small spark is produced between the ball terminals of the resonator. Even although the resonator and the spark balls are connected by the resonator wire, this does not hinder the creation of the spark, as the inductance of that wire makes it a practically perfect insulator to very suddenly applied potential differences.

If, however, the resonator is held in a position so that the line joining the spark balls is in a direction at right angles to the spark axis of the oscillator, then no spark will occur in the resonator, because the electric force arriving there is not in a direction to create potential difference between the balls. If, however, the plane of the resonator is in the plane containing the base line and the spark axis of the radiator, and if the spark gap of the resonator is so placed that its direction is perpendicular to the axis of the vibrator, then feeble sparking is seen in the resonator. This, however, is because the electric force distribution is disturbed by the metallic circuit of the resonator.

The direction of the electric force, and, therefore, the displacement traveling through space is then in the neighborhood of the spark balls of the resonator no longer parallel to the spark axis of the radiator, but is slewed round so as to be inclined in a direction to the spark axis of the resonator. Hence the effect is to cause a displacement across the air gap of the resonator, and therefore to create a spark.

We may ask then, what are the functions of the wire of the resonator if the spark formation is due to the action of electric force propagated from the oscillator? To answer this we must analyze a little more closely what takes place in the resonator when the spark passes.

The resonator is a circuit possessing capacity and inductance, the spark balls forming, so to speak, the condenser portion of the circuit, hence it has a natural free period of electrical vibration. If in the space between the balls alternating electric displacement is produced, being propagated to that point through the dielectric, this displacement may or may not synchronize in period with the free period of vibration of the resonator. If it does time in with it, then the amplitude of the displacement oscillations is increased, and a point is reached at which the air oscillation breaks down and a spark then passes.

Owing to the fact that the resonator is a nearly closed circuit, it is a very bad radiator, and as Bjerknes has shown (Wied. Ann., vol. 44, p. 74, 1891), such a resonator has a very small coefficient of damping. If it is a circular resonator, 35 centimeters in diameter as used by Hertz, it may make 1,000 vibrations before the oscillations are damped out.

It is obvious, therefore, that oscillations can be most easily set up in the resonator circuit when the vibrations of electric displacement, which give rise

Fig. 4.

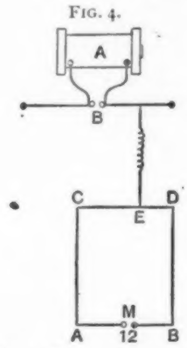
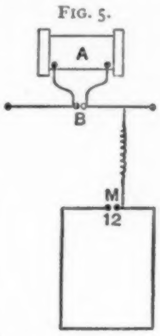


Fig. 5.



Hertz Resonator attached at an unsymmetrical point by a wire to a Hertz Oscillator and having sparks produced at its spark gap M.

to these oscillations propagated to the spark gap, are in a direction parallel to the spark axis of the resonator.

(To be continued.)

TRADE SUGGESTIONS FROM UNITED STATES CONSULS.

Spanish Exposition of Fuel and Heating Appliances.—Consul-General Lay sends from Barcelona, February 22, 1901, translation of prospectus of an exposition of Spanish mineral coal, to be opened on April 30 and closed on June 29 of this year. Mr. Lay adds:

It will be noticed by the prospectus that a special exposition will be held at the same time of different systems of hearths, grates, accessories, and other general appliances, whether native or foreign, for more thoroughly utilizing the fuel. This exposition should be of great interest to our manufacturers, inasmuch as it is the first one of its kind held in Barcelona.

Those intending to exhibit may be glad to know that there is a direct steamer leaving New York for Barcelona every month about the 7th—Compañia Transatlantica; agents, Ceballos & Company, New York. From information at hand, I should think their interests would be best served by employing one or more persons here to receive, mount, and display their exhibits. I have written the chairman of the committee of this exposition for further particulars regarding privileges of free entry and space allotted exhibits, which will be forwarded as soon as received.

I have also written the committee to grant American exhibitors the privilege of admitting their applications until the 25th of April and exhibits until the 25th of May, as I have only just heard to-day about this exposition, and there is not sufficient time for this report to be distributed among those interested in the United States and for applications to reach here, nor is there constant direct steamship communication.

The prospectus reads:

EXPOSITION OF SPANISH MINERAL COAL.

With the desire of acquainting manufacturers with the natural wealth of the country in regard to fuel, the Provincial Council of Barcelona will hold an exposition of Spanish mineral coal, including all from anthracite to peat in all their varieties and comprising also patent fuels and waste products, as also pitch and tar, and those mineral bitumens used in the making of patent fuels.

Exhibits will also be admitted of machinery and appliances directly connected with the coal trade, as also of the products derived from that industry; but these will not be competitive.

At the same time, a special exhibition will be held of different systems of hearths, grates, accessories, and other general appliances, whether native or foreign, for more thoroughly utilizing the fuel.

At least 2 cubic tons of the fuel to be exhibited must be sent, which must faithfully represent the current type and quality obtained in the working.

Intending exhibitors must send applications to the secretary of the "Diputacion Provincial," of Barcelona, before the 15th of March next, on forms which will be supplied to them, stating the conditions of the fuel and particulars of the mine, or, in the case of an artificial product, particulars of the works must be given. Exhibits must be received by the committee before the 15th of April.

The charges on machinery and appliances connected with the coal trade, and also those on hearths, grates, and other accessories for the use of fuel, must be defrayed by the sender or exhibitor as far as the site of the exposition, as also the cost of installation and the return of the exhibit.

PRIZES THAT MAY BE AWARDED TO MINERAL FUELS.

Anthracites.—A first prize will be given to the anthracite which, coupled with the highest heating power (not being less than 7,000 temperatures), can show a normal output of at least 10,000 metric tons annually. Two second prizes will also be awarded.

Pit Coal.—A first prize will be given to the pit coal that, besides having the greatest heating power (provided this be not less than 6,500 temperatures), combines the best physical qualities, contains fewest impurities, and can show a possible annual output of at least 25,000 metric tons. Two second prizes will also be awarded.

A first prize will be given to the pit coal which, with the highest heating power (not under 6,000 temperatures), combines the best physical qualities, contains fewest impurities, and whose possible annual output can reach 100,000 metric tons or more.

Lignites.—A first prize will be awarded to the lignite which, with the highest heating power (not under 5,000 temperatures), combines the best physical qualities, contains fewest impurities, and can show a possible annual output of 10,000 metric tons or more. Two second prizes will also be awarded.

A first prize will be given to the lignite which, with the highest heating power (not under 4,000 temperatures), combines the best pnysical qualities, contains fewest impurities, and which can show a possible annual output of 30,000 metric tons or more. Two second prizes will be awarded.

Peats.—A first prize will be awarded to the air-dried peat which, with the highest heating power (not being under 2,500 temperatures), combines the best physical qualities, contains fewest impurities, and whose bogs have an annual capacity of 10,000 metric tons or more. Two second prizes will be awarded.

Patent Fuels.—A first prize will be given to the coal bricks which, with the highest heating power and fewest impurities, are the best manufactured, contain the smallest proportion of tar, and have the largest output. A second prize will be awarded as accessory to the foregoing.

Coke.—A prize will be awarded to coke, derived from native mines, which combines the highest heating power with the best conditions of density and purity, and with a possible output of at least 10,000 metric tons.

Business Conditions in Beirut.—Owing to overspeculation and to a collapse of the silk trade, Beirut is at present passing through a crisis which will affect its commerce for perhaps a year to come. The losses from disastrous cotton deals and the sudden drop from 51 francs to 38 francs per kilogramme ($9.84 to $7.33 per 2.2046 pounds) in the price of raw silk, due to the failure of the Paris Exposition to dispose of accumulated quantities of silk manufactures, are said to amount to something like £250,000 ($1,216,625). A number of significant bank and business failures have also occurred, affecting both home and foreign interests. Money is being withdrawn from circulation, and, until confidence has once more been restored, local conditions will be strained.

The commercial interests of the United States have not suffered, the sagacity and prudence of our merchants in financial dealings with levantine mercantile houses being proof against such flurries. The refusal of our exporters to adopt the wide open policy of certain European countries, in offering credits and consignments and inferior articles, is highly commendable. American manufactures are gaining ground in Syria, in spite of stricter terms of payment and sometimes higher prices, because of their superior qualities.—G. Bie Ravndal, Consul at Beirut.

Russian Emigration to America.—Consul-General Guenther writes from Frankfort, January 31, 1901:

It is reported from St. Petersburg that the people belonging to the religious sect called Duchoborzens have left the Caucasus and found a new home in Canada. The Molukanes, another Russian sect residing in Transcaucasia, also wish to emigrate to North America. They number about 50,000, and are located in Tiflis, Jelisawetpol, Baku, and Kars. They are known as industrious agriculturists, and are prompted to emigrate on account of lack of land and increased taxation.

Index to Advance Sheets of Consular Reports.

The Reports marked with an asterisk (*) will be published in the Scientific American Supplement. Interested parties can obtain the other Reports by application to Bureau of Foreign Commerce, Department of State, Washington, D. C., and we suggest immediate application before the supply is exhausted.

TRADE NOTES AND RECEIPTS.

Durable House Paint.—Prime with zinc white and let this be succeeded by a coating with zinc chloride in glue water (size). The zinc oxide forms with the zinc chloride an oxy-chloride of great hardness and glossy surface. By admixture of pigments any desired shade may be produced. The zinc coating is indestructible, dries quickly, does not peel, is free from the smell of fresh oil paint, and more than 5 per cent cheaper.—Neueste Erfindungen und Erfahrungen.

White Coating for Wood.—Christoph Hartl, of Hamburg, applies a durable white coating on wood in the following manner:

The surfaces of the article are rubbed dry by means of ammoniac and the filling of the pores performed with albumen. On the surface thus prepared a polish consisting of white shellac, spirit and a few drops of oil is applied, and when the priming has been put on, Krems white is added to the polish, for body color. Subsequently the surfaces are treated alternately with ammonia, albumen and polish until they have acquired after eight repetitions of this treatment an intensely white coat. Same is fixed by putting on a copal polish.—Lack- und Farben-Industrie.

Utilization of the Residue in the Manufacture of Acetylene.—As is well known considerable quantities of calcium hydroxide are obtained as a by-product in the manufacture of acetylene gas. About 40 per cent calcium hydroxide remains behind. Since lime is extensively employed in agriculture, especially in vine-growing and in the fruit-culture, this residue is excellently adapted, according to Brouzel, to take the place of the frequently inferior caustic lime of commerce. Besides, it possesses the further advantage of not becoming transformed into carbonate so readily as caustic lime. Calcium hydroxide is especially useful for liming grain. Not only in agriculture, but also in industries such as the manufacture of chloride of lime, and of alkalies, as well as in soap factories, calcium hydroxide may be employed with advantage.—Pharmaceutische Centralhalle.

Removal of Tar Dye Stains from the Skin.—Manipulations with tar dye solutions (red ink, dye solutions used in experimenting, etc.) frequently entail disagreeable discoloration of the skin of the hands. A very sure remedy for a quick removal of such dye stains is afforded by chromic trioxide. All that is necessary is to rub the stained skin with a pinch of the slightly moistened red crystals until a distinct sensation of warmth announces the destruction of the dye stuff by oxidation and an incipient itching of the skin. After that, rinse with soap and water and the spots will have disappeared. Very seldom a repetition of this simple process is necessary to attain this end. It is hardly necessary to call attention to the poisonousness and strong caustic action of chromic trioxide; but only moderate caution is required to avoid evil side effects.—Neueste Erfindungen und Erfahrungen.

Utilization of the Shock of the Waves for Power.—An electric firm has conducted tests at the mouth of the Elbe with a view of utilizing the force of the waves for an automatic electric illumination of the buoys moored at dangerous places near the shore. After prolonged experiments the solution of this problem has been attained and the first electric light buoy is now in operation. It was stationed before the town of Büsum on the coast of Holstein at the dangerous sand banks there. The buoy is so constructed that even a slight motion of the waves sufficed to generate the electricity necessary for the prescribed luminous power. By a clockwork in the interior of the buoy the lighting up and extinguishing of the light, which changes every half minute, is accurately regulated. This buoy has given such satisfaction that similar buoys will doubtless soon be extensively introduced.—Neueste Erfindungen und Erfahrungen.

New Artificial Polishing Medium.—An artificial polishing agent to grind and polish hard bodies, such as porcelain, glass, steel, etc., is produced by making chamotte earth with water into a paste, then drying and burning at 1,200 to 1,300 deg. C. The product thus received has the hardness of emery, 8 to 9. If the chamotte does not melt at the above temperature, about 10 per cent of feld-spar or 2 per cent of unslaked lime should be added. After the burning the mass is ground and finely sifted.

For the production of grindstones and polishing-stones, take 40 parts of the mass, 45 parts of chamotte earth and 15 parts of emery; make a paste with water, press it into molds and dry at about 800 deg. C. The polishing qualities of this artificial product are said to be greater than those of Naxos emery. The wear is slight. The cost of production is about one-half of that of emery-stones.—Journal der Goldschmiede Kunst.

Ozone as an Antiseptic.—For the purpose of sterilizing and cleaning ill-smelling and putrid beer kegs the following process was employed. Where the casks and other receptacles were not too much soiled they were first washed and steamed, and next ozonized air was blown in direct through the bung hole. In cases where the kegs were much soiled and ill-smelling and the interior showed numerous micro-organisms they were partly filled with water, and ozonized air was introduced through the water by means of a tube.

When in a very foul state the casks were first chemically cleaned with sodium hypochlorite or magnesium hypochlorite solution; sometimes the chlorine was freed by adding a small quantity of acid, the kegs were closed and shaken vigorously; next they were treated with ozonized water until the last traces of chlorine were removed. In this manner very foul and ill-smelling casks were rendered perfectly sweet and free from mould and bacteria.

Exhaustive quantitative tests instituted by the author with the wood of the interior of the kegs revealed that the number of bacteria, which were innumerable before the disinfection, had decreased to but a few after half an hour's treatment. The author tested the behavior of ozone to yeasts and bacteria, and found that bacteria are more sensitive to this disinfectant than the yeasts.—Zeitschrift für das gesammte Brauwesen.

THE

Scientific American Supplement.

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